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THE CHANUTE-MOUIILLARD CORRESPONDENCE

April 16, 1890 to May 20, 1897

Being the letters exchanged between Octave Chanute,
American engineer, and Louis-Pierre Mouillard, French
author and student of bird flight, mainly on the subject
of aeronautics.

NOTICE

AFTER CAREFUL EXAMINATION OF THE
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SO IT CAN BE MORE EASILY OPENED
AND READ.

Ostave Chanute

THE CHANUTE-MOUIILLARD CORRESPONDENCE

April 16, 1890 to May 20, 1897

On the subject of flight.

Translated into English by Eugene Moritz (1878-1946)
of New York City and Dr. M. Louise Kraus (1893-1961)
of Leudelange, Luxembourg.

Edited by Juliette Bevo-Higgins of Pottsville, Pennsylvania.

The work undertaken at the request of Pearl I. Young of
1262 Lititz Pike, Lancaster, Pennsylvania, who has
authorized E. L. Sterne, aeronautical bookseller, of
2949 Balboa Street, San Francisco, California, to sell
the only 12 copies available.

Lancaster, Pennsylvania

1962

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NASHVILLE

PREFACE

These translations of the correspondence between Octave Chanute and Louis-Pierre Mouillard are not intended for highly technical usage. For such a purpose the letter-press copies of Chanute's letters and the original Mouillard replies should be consulted. They are in the manuscript division of the Library of Congress.

Shortly after the death of Chanute in November 1910, his daughters were approached by a member of the French Ligue Nationale Aérienne, who borrowed from them the letters Mouillard had written to their father, on the excuse that the Ligue wished to see that Chanute got due credit for the aid he had given Frenchmen on aeronautics. A list of the letters by date was retained but no copies were made. The letters were not returned as promised.

Only years of effort by French engineers and lawyers produced the return of the letters that are produced in this volume. From the dates kept of the letters listed here as "Missing" and from Chanute's replies it is clear that the retained letters contained details of proposed inventions. Their retention in France was apparently intended to forestall any denial of the ridiculous charges made by a few chauvinistic Frenchmen to the effect that Chanute had made a dupe of Mouillard and stolen his ideas so that an American, not a Frenchman, would be the first to fly. A copy of one of the retained letters dated December 10, 1891 was available from the S. P. Langley correspondence. Chanute had sent him a copy because in it Mouillard gave Chanute permission to share everything with Langley.

Lancaster, Pennsylvania
October 20, 1962

Pearl I. Young

INTRODUCTION

There being no preliminary letter from Chanute to Mouillard it would appear that the correspondence started when Octave Chanute, having read Mouillard's book "L'Empire de l'Air," mailed him a copy of the talk Chanute gave in Paris August 1, 1889 at the Congrès International d'Aéronautique. It was printed as

Chanute, O.: Note sur le résistance de l'air aux plans oblique. L'Aéronaute, vol. XXII, September 1889, pp. 202-214.

and reprints were available in both French and English.

The Chanute-Mouillard Correspondence
 April 16, 1890 to May 20, 1897

Octave Chanute was born in Paris, France, Feb. 1832, and died in Chicago, U. S. A., Nov. 1910.

Louis Pierre Mouillard was born in Lyon, France, Sept. 1834, and died in Cairo, Egypt, Sept. 20, 1897.

Cairo, Egypt
 April 16, 1890

Mr. O. Chanute
 Chicago

Dear Sir:

I thank you for your kindness in sending me your pamphlet on "Air Resistance of Oblique Surfaces."

I have read it in "L'Aeronaute", but I am going to read it once more with much attention and extreme pleasure.

I must confess that I have the deplorable habit of paying little attention to writings pertaining to pure mathematics, because of the difficulty I have understanding them. There is also my intellectual laziness which makes me go over most of these writings too lightly.

I have to admit that this is wrong. The best proof of it is your treatise, because in reading it I came across two items which interest me very much.

One is the reference to the narrow wing of speedy soaring birds. Then there is the plain truth, which you present mathematically at the end of your note in reference to the dirigible balloon, a truth which cannot be shouted loud enough, because the balloon is the enemy of the airplane.

It is the balloon that impedes the development of this difficult problem, which soon will need all support instead of obstacles. This means, Sir, that I am a partisan of the purest of aviation. I do not know whether you are acquainted with the fact that I took the liberty to write a book on this problem: "Empire de l'Air" published by G. Masson 1881. At present I am preparing a continuation of this work which will be titled: "Le Vol Sans Battement" [Flight without Flapping Wings] and which will appear within a year or two.

I refer to the final part of your treatise which provided the stimulus of the present letter.

Sir, I cannot advise or criticize by means of mathematics, as this would be too difficult for me; but approaching the problem in another direction I could perhaps be of some assistance to you by means of observation, a field in which I am entirely at home.

In case some theoretical problems are confronting you in your experiments I would like to put my professors at your disposal. They are neighbors of mine, two vultures, which are brilliant demonstrators.

I beg you, Sir, to accept my enthusiastic greetings,

Mouillard

May 15, 1890

Mr. L. P. Mouillard
Cairo

Dear Sir:

I derived great pleasure from your letter, for I have the greatest estimation of your investigations and your book. I procured several copies of the latter at the time of my visit in France.

Not only have I found much confirmation of the theory which I had outlined, but also many facts which were new and interesting to me, and I am impatiently awaiting the publication of the new book you informed me about.

Science rests on observation and the principal advantage of theory is to give us general laws to coordinate and to verify the observations. I therefore consider your investigations to be of the greatest value, but it is possible that the mathematicians may be helpful to you by confirming or affirming the conclusions you arrive at by instinct.

For instance, I believe I am able to tell you, why you are absolutely correct when you say on page 272 (Le Empire de l'Air) that an airplane with cut-outs operates almost as well as one without, for if I have reason to believe that the stream lines are deflected by the bottom surface, non-compressed air cones A A are formed which close these openings. In the sketch below

I have the angles between them greatly exaggerated; they are about 1° for a speed of 10 meters per second.

On the other hand, I believe that you have found out long ago that the characteristics which you state on page 210 should be modified as follows: "If a body moves, its center of pressure is displaced and is transferred toward the front in the direction of the movement".

It is this continual displacement of the center of pressure, in proportion to the change of the angle of the wind which, to my mind, makes the longitudinal stability so difficult, so that almost the instinct of a bird is needed to maintain balance constantly. I would like to know whether your two vultures have imparted some knowledge to you on this subject.

I also would like to know whether you have made observations on the resistance of the fore part and the rear part of large soaring birds of which you speak on page 46. These observations would be very important, and if I should happen to be somewhere where soaring birds have their habitats I shall make these observations myself.

Do you read English? I take a chance in mailing you a booklet by Lancaster who spent five years in Florida to study large soaring birds. You will find some surprising remarks in this book, but it is not necessary to depend on his theory as to cause and effects, because he is entirely mistaken.

I should be pleased to receive another letter from you and to be of service to you if this is possible.

Accept, Sir, the assurance of my highest esteem.

O. Chanute

Cairo, 14 June 1890

Mr. O. Chanute
Chicago

Dear Sir:

I thank you very much for your kind letter and hasten to answer your questions.

It is a good thing that those who try to solve this irritating problem communicate with one another. There should be a fellowship comprising many individualities to overcome any kind of difficulty before it causes any damage. What someone knows, someone else does not know. This caused me to say in my second book that the greatest danger to aviation is the spirit of mystery in which those who take up the study of aeronautics generally cloak themselves.

How could you, by simple reasoning, arrive at the theory of the compressed air cones? This proves again that everybody acts according to his talents, and I have no talent for pure mathematics. I found the confirmation about slotted planes by means of plain and simple observation. I watched birds whose wings lacked some feathers and this lack had little effect on their flight motion. The next step was to repeat this experiment with a paper airplane model. I did, and kept on doing it until it became quite absurd. The result led me straight to the consideration of superimposed planes.

Let us now discuss the law of attraction which I have promulgated and which, I must admit, has brought me considerable criticism.

First of all, Sir, I ought to tell you that I do not adhere absolutely to this mode of a statement; this puts us at ease in discussing it.

The first thought that comes to mind is certainly that of the displacement of the center of pressure and not that of the displacement of the center of gravity. That is the way I thought when I saw birds which were thrown out of balance; they changed their configuration and regained their equilibrium by means of their speed. In this case at the first view there is no possible error. It is very probable that a displacement of pressure takes place and that the body of the bird is moved by the action of this pressure to a point other than the center of the figure. I then reconsidered the law you refer to. However, several years before my book was printed, I had time to observe and to study the action of this displacement of the center of pressure on other objects besides birds.

I observed in succession: the moving steam ship whose fore part rises, the locomotive which at full speed seemed as if it wanted to take off from the tracks, so light became the front part. I asked myself whether the action of the air was sufficient to create such an unbalance on a mass so dense. Doubt impressed itself firmly in my mind. In order to clarify this perplexing case I tried to think of a way to eliminate the action of the air current, and I succeeded in the following manner. I simply took small scales which had no external beam such as are used in every shop. The mechanism is enclosed in a box and consequently beyond the action of the air current.

By imparting to these scales a motion in the direction of the longitudinal axis of their beams, the center of gravity if it is in question, will be put in arrear of the direction of the motion; the lever arm of the front platform becomes therefore longer, as the pivots have been fictitiously drawn back, and under these new equilibrium conditions the front platform should move downward, as was actually the case as soon as a motion was imparted to the scales. We have now before us a case which is explicable by a law such as promulgated and all one has to do is to substitute the word "pressure" for the word "gravity".

By pursuing this study further I find myself face to face with experiments which indicate also that the action of the center of pressure is very strong, so that now I begin to think that the two expressions are correct, because I have convinced myself that both actions exist.

In what proportion do they act? I do not know. Unknown roads are hard to travel. It would be necessary to devote to their study more time than I have left. In short, what I intended to describe is an unbalance in relation to the speed of the body, and since such a law is promulgated it permits an explanation of the motions of the bird airplane. That is all I have been looking for.

As to the air resistance of the front part and the rear part of a bird, I have considered it for quite a long time and observed not only winged creatures but also swimming creatures. This forms the subject of two long chapters of the book which I am writing, but owing to lack of space I am able to give you only the conclusion. Here it is: "In a creature perfectly endowed by nature to fly or to swim, drag may be disregarded."

You ask me, Sir, when my book will be published. I cannot tell you. First of all, I need some pocket money which I am lacking; then, and this is important, to be able to make an effort of self-denial, upon which I have not yet decided. In this book I am telling everything I know not only about aviation but on other problems. For instance I speak about three balloons which would certainly bring fortunes if they were in other hands than mine. I come to the kites and discover there some curious machines. In these two chapters I tackle the problem profile of fast ships — and all this always by the same procedure: observation. Yet, I confess, the profile of ships is

one of my old hobbies. But if I had found this out twenty years earlier, I would have brought navigation twenty or more years ahead of time.

In short, I lay myself completely bare, and despite of being a good giver, I cannot decide to give this. Perhaps later, when I am absolutely convinced of my ineptitude to deduce even a little profit out of an idea, I shall bring myself to do it, but this time has not yet come.

In the meantime, Sir, if some points which I may know should be of interest to you, I shall be glad to be always at your service.

Sir, please accept my most cordial greetings.

Mouillard

Chicago
22 October 1890

Mr. L. Mouillard
Cairo, Egypt

Dear Sir:

The great frankness and the gloomy abnegation which your letter of June 14 expressed touched me deeply and created my urgent wish to be of assistance to you if possible.

You are perfectly right, indeed, if you do not wish to lay all your cards on the table as long as there is some hope of success. Although you justly blame the spirit of mystery, there are many things which one cannot lay bare to everybody.

I asked myself very seriously whether it is the element of success you are lacking and whether the theory could not point to a solution. In order to go deeper into this matter I have read your book again very carefully and it seems to me that what you are lacking in attaining your goal to rise in the air when there is a strong wind, is the longitudinal equilibrium and the certainty that your machine does not turn a somersault under any condition.

It is rather easy to get the transverse equilibrium; either by the application of the V shape which increases resistance, or by giving the machine a vertical keel or by applying both suggestions. However it is much harder to get longitudinal equilibrium without an increase of resistance. But none of the solutions offered are in my opinion satisfactory for a machine larger than a bird.

The shape of the bird and the necessity to fold its wings give it an unstable equilibrium and for these reasons the bird became an acrobat. I believe, as far as I am concerned, that it is true I should not even dream of imitating the bird, but I also believe that it is possible to apply the same principles in a different manner, and that perhaps the theory will indicate the means with which to obtain a stable equilibrium.

Before I approached this problem to make it applicable to your purpose I had hardly devoted myself to it. Up to now I studied the laws of flight rather than thinking of a design, and if I make one, it will be a machine powered by an engine, to be flown fast in any kind of weather.

In reference to your case, I had to make some experiments which explains why I did not answer your letter sooner. I believe I have found something useful which I think to be new. I am sending it to you under two conditions which I kindly ask you to accept mentally before reading the enclosed sheet (No. 3 & 4).

1. The idea is for you only. If it is successful I want you to say afterward that you received it from me.

2. If afterward a patent for its application should be taken out, the European patents are for you and the American patents are mine for the entire machine.

This is to show how I was guided by reasoning, based on the idea that the streamlines separate in front of the lower plane:

AB is the section of the plane and ABDE is the air prismoid which rests on a thin plane. If the plane takes the position AC, the prismoid having the same separation of the sides, is now indicated by ACFG. It is evident that there will be a relatively large preponderance of molecules on the front of the plane and that the center of pressure moves forward.

According to the ratio in which the angle of incidence becomes more pointed the center of pressure moves forward. The arm of the lever increases toward the front edge and the equilibrium is disturbed.

The question now is to limit as much as possible any movement of the center of pressure, yet without decreasing the lifting surface. A bird is able to act against the motion of pressure simply by varying its center of gravity. But take a large machine which has a wing 5 meters wide. The center of pressure may vary by $1\frac{1}{2}$ meters between 45° and 1° of inclination but there is no chance to vary the center of gravity quickly enough over this distance.

In order to resolve such a difficulty on a machine it will be sufficient to cut the plane or the wing into narrow strips and place them one behind the other at such a distance that the pressure prismoids which rest on the strips do not interfere with one another. Next, to suspend the weight of the body as low as it reasonably can be done. The centers of pressure are easily displaced across the strips at the same distance according to the width of the latter. But this distance is small, if the wing of 5 meters is cut into 10 strips, the displacement of the center of pressure will only be 0.15 m instead of 1.5 m.

This leads to the idea of superimposed planes, but it will be well to guard against any over-confidence. For the machine no longer would be a parachute if the planes were concealed behind one another and so to prevent the creation of vertical prismoids during the descent.

Take your piece of carton of page 210, cut it in four or eight strips and paste them behind one another on one or several keels in such a way as to leave a slight space between these strips. Then make a very slight "correction fold" of about 3° to 5° toward the rear and drop the carton by the edge as before. You will note that, instead of making a turning motion, it will straighten out and drop vertically, without fail.

I believe this is the principle of the longitudinal equilibrium for a machine. For very good reasons the bird does not need it, but it makes the "correction fold" by means of its tail, and changes its center of gravity. As to the practical application, I have several ideas about it, but I do not wish to send them to you until I know whether I have guessed correctly what you are looking for and what your designs are for a machine. Please answer me soon.

Please accept my most cordial greetings.

O. Chanute

Cairo, November 20, 1890

Mr. O. Chanute
Chicago

Dear Sir:

Thanks for your kind letter and for the sympathy expressed therein.

Thanks also for the idea which you intend to send me.

Today I am forced to make a confession which becomes very painful to write down, but there is no use to conceal it; It is disgraceful, but here it is: I did not understand!

I am so impervious to any mathematical statement that it does not surprise me; but what will somebody else think of it; it seems strange, I admit. I am one of those who solve a problem, even a difficult one, very easily in their own way, but who are unable to understand a statement of it, if this statement assumes the aspect of a formula. That's how matters stand and I have not succeeded in reforming myself. I have picked up your letter ten times, trying each time, with an enormous effort, to comprehend it. I could not understand that letter if you would kill me, those prismoids keep on dancing in my head, I am getting dizzy. And yet I have spent my life studying them, but always in my own way.

I never was able to make an algebraic division, a fact which instilled a holy terror into me against algebra. This fact stands out vividly in my books to the great dismay of those who understand that there is still something in my brains.

While I am in a confessing mood, I may as well go the whole way. I never use formulas for simple cube calculations; also to determine the volume of a sphere I do not use $\frac{4\pi R^3}{3}$, No! This frightens me. I am

afraid that I may make a mistake. I prefer each time to say to myself: A sphere may be considered to consist of a series of cones; the surface of a circle as a multitude of triangles, etc. This is always the very same thing but without a formula.

In spite of all this, I calculate very easily and correctly. Very often it happens that I arrive at my results so quickly as to enable me to check whether the others have made a mistake in their calculations. -- Physics I know fairly well, am rather skilled in chemistry and not bad in the sciences ending with "gy". I even have been a surveyor, always using my own methods which are of mystifying accuracy. In short, alas! I am as usual different than anybody else. My family claims that I acquired this trait from my foster mother who was a she-goat. There certainly seems to be some truth to it, because if I look back to other phases of my life I notice that I am always off the beaten path.

This is my great misfortune, I know it. But is it possible to reform without becoming a nonentity? I do not believe it.

However, if you would explain to me by word of mouth what I could not understand even by reading your letter ten times, I am convinced that I probably would grasp it in five minutes.

Your good letter contains also an other point which I could not understand and which surprised me very much. You say that the longitudinal equilibrium which I have expounded is very hard to achieve and requires an amount of energy much larger than the human body is able to furnish.

The vertical equilibriums obtained by the airplane fig. 30 is a simplified copy of that of the bird; that is the method it uses. Experiments with well-designed machines, especially when they attain a largeness, give surprising results. I have tried it with an airplane which had a span of five meters and during the second test I obtained this perfect equilibrium: There is nothing more steady and more regular than the motion of translation. The airplane was thrown from the top of a quarry, a height of 70 meters, and it landed about 300 steps away in absolute still air.

I can no more go back to that quarry, because it is too far for me. However there will be a chance some day. They propose to build a railroad in order to establish a sanitarium on top of the mountain. Thanks to this railroad I hope to renew the experiment next summer and to use an airplane which has a surface of about 20 square meters and which has been built some years ago. This machine is designed to carry a man, but due to my inability to move I have never tried it.

The experiment will therefore be extremely momentous. I shall write you the results of it as soon as I have done it. — I refer to figure 30.

I am going to put progressively (1) sand bags in the machine in the place where the aviator is supposed to be, and some young men whose lives have been poisoned by my book are going to launch the machine. I am going to provide its front part with cane to ward off shocks, and hope that it will perform well.

It seems to me that you gained this impression because you had little occasion to observe very large birds. The minute you will be able to study the great vultures or the condors you will change your mind. The sight of a vulture makes it perfectly easy to believe that vertical control is a difficult feat, but seeing a large vulture take-off or in flight or alighting, simplifies this question completely. By seeing its slow and simple manoeuvres one understands that the average human energy is perfectly capable to reproduce them.

As to the problem of horizontal control I have not been explicit enough in my book.

As you have been so kind to favor me with an idea, which alas!, I could not digest, I, on my part am going to augment this point which is entirely incomplete.

This control as explained in my book is taken directly from nature, but these control actuations are slow. The fast ones are produced in a different way. I assert that when a bird is going to make a turn to one side, it deflects the wing of this side and the small wing always points toward the center. — This is a fact, but entirely insufficient.

Here is the complement of this manoeuvre: The sixth and the seventh feathers of the "hand" of a bird — see figure 12 where they are easily visible — are, what I call, annular feathers. They have the largest surface of all the feathers of the entire wing. When the bird is about to turn, it cuts the air with these feathers. The wing tip twists ... That warped part of the airplane does not glide any more as compared to the corresponding part of the other. These feathers obstruct the motion, they stop it, forming a long lever on this point. This causes a variation of motion and a rapid change of direction.

I have reproduced this effect several times, using various means, always with success. — This is the fast action of horizontal control. The shifting of the mass to one side and the decrease of the surface on the same side are not to be compared as an action of direction with the rough means of direction control.

The first ones are applied in soaring flight when a circle is about to be flown, and the latter in free navigation.

Here you have then the picture of a bird at its two aspects of useful motions which we wish to reproduce. The other faculties of the bird, which enable it to fold its wings etc. are of no interest to us. With these two modes of control we will be able to reproduce cross-country flight at an average time: That is all I want to reproduce.

Actually I am going deeper into this matter to consider construction details. At the same time I have put aside the airplane type represented in fig. 30 in order to construct a simpler and more perfect one. Then I am going to resume work on the engine-powered airplane fig. 31 by simplifying it considerably. That is the one I call the "machine for those who are impotent" — that means me. With this I want to say that I am trying to get around the difficulties which a personal airplane presents, and besides to have the experience of getting a ride in the air.

As you see, Dear Sir, despite my discouragement, despite the gloom to which I am resigned and to which I seem to be condemned, I do not let loose of the problem. I am holding on to it coldbloodedly and have my reasons for doing so. How would it be possible to forget such a problem, especially when the soaring birds are always performing in front of one's eyes.

What I need to succeed is a little comfort, a little freedom of action. I am frustrated too much by the necessities of life, to be able to act with success, and not means enough to evolve an idea with a chance to succeed. I discover that in my files some designs are getting mouldy which, in more active hands than mine, would be quickly executed and made profitable. First of all, those pertaining to aviation which I am giving to the whole world. My life has been such a disillusioned one that not only do I not believe in anything but I do much thinking and little acting: This is my shortcoming. I should have two masters, one for thinking and the other one for action and to get the better of the thinker.

In 1881 I surely thought that the time of my freedom of action had come. While I was publishing my book in Paris, I tackled another problem just as important as that of aviation. It had to do with changing extant conditions in the French Navy from top to bottom. I had been received several times by Gambetta in a way which looked very promising. This great man showed great interest in my ideas. Unfortunately all my hopes collapsed with the death of this brilliant man. Today I am in touch with Admiral Aube, former Minister of the Navy, the man who said that the day of floating "cathedrals" has passed, and that it is necessary to apply new ideas. Who knows whether he will get back into power?

This blow drove me back into my hole in Cairo which I shall never leave again. And yet this idea is so new, as up-to-date as it was twenty years ago when I evolved it.

Last summer I had the pleasure of receiving a call of one of your acquaintances, the Russian engineer Drzewiecki. He told me about you and about the exposition in Chicago where he said he went. According to what he had to say you gentlemen of the United States are doing well. You want to do everything in great style and beautiful. He spoke to me about a flying machine which he intends to build. During his entire conversation he watched the small vultures and the crows nearby. Unfortunately M. Drzewiecki was out of luck; during his two weeks' stay I could not show him a single large vulture. This was too bad as I might have been able to convert him to flight without flapping wings.

However this extraordinary exposition and the daring people who arranged it keep running in my head. I wonder whether there would not be any possibility to exhibit in your country some new ideas and get something out of it. As far as France is concerned I have given it up because they are all wet hens.

Would you be kind enough to tell me whether among the following ideas would be some which could be utilized profitably. I selected those which may have some connection with an exhibition:

1. Constant propeller, with a uniform efficiency at any speed: Good for air and water.

2. My ideas on airplanes (design). These are the improved machines fig. 30 and 31 I told you about. The first one should be able to fly if in the hands of a man with ordinary strength who is well versed in flight and flight manœuvres. The second one depends on the possibility to attain on a water surface a speed of ten meters per second with a machine which weighs 500 kilograms.

3. Look-out post for the Navy and whaling boats. This is the seagoing balloon which has been tried out recently at Toulon and in Germany without success.

4. Alpine balloon, an attraction for an exhibition. An amusement which certainly should bring in money. It is a delightful device which will carry off the young people, ladies as well as gentlemen. These are ascents to be made on the exposition grounds not very high and without danger. These ascents may be extended to any length of time. I have only one regret i.e. that I have been unable to build this machine. It would have been a nice pastime to do so, and even sick as I am now I would be the first one to try it out, had the balloon been built.

5. A kite equipped with an engine.

6. A dirigible balloon without propulsive machinery. This is the machine referred to on page 11 line 11.

7. Sorting device for minerals which only uses the water drained off the ground.

8. Dew condenser. A complement to the preceding device. Both are meant for regions where there is lack of water.

9. Balloon valve, which permits as many valvings as may be required, an operation which cannot be performed with present-day valves.

10. Torpedoes for the Navy.

In case something among these ideas looks usable to you, please let me know whether you want to take it up with me and under what conditions. — My share would be the idea. I do not need to tell you that I am not a capitalist. I have proclaimed it from the housetops and everybody knows it. I would not dare to offer my active participation due to my poor health. Chicago is too far away, above all from New York. If this trip could be made by ship it would be all right but a thirty-hour ride on the railroad seems rather somewhat too long for my constitution.

After reading this long letter you must think me to be very verbose, very bold, and very inquisitive. Please excuse me and blame it on the charming kindness which radiates from your kind letter. So if I have been too long winded, it could not be helped.

Please accept, Sir, a hearty handshake from your very devoted

Mouillard

30 December 1890

Mr. L. P. Mouillard

My Dear Sir:

I received your kind letter and I must admit it is I who was mistaken. As you have guessed correctly I never have observed any large bird. We do not have them here. But according to what you said of their maneuvers to maintain their equilibrium and the precautions you point out on pages 256 & 257 "In order not to be in distress every minute and obliged to put the machine in V", I thought that it was the longitudinal equilibrium which made you hesitate, and that I might render you a real service by sending you a solution.

I am certain that you grasped that solution since the time you wrote me. It is so simple to divide the wing surface into a series of narrow strips which are placed behind one another with a very small space between each of them. Enclosed you find a pasteboard which explains the whole matter. When you drop it sideways it will start to rotate and when you drop it tail first it will fall straight downward.

I ask you to keep this experiment a secret. Since I am in the mood of confessing I must tell you also that I did not understand at all the figure I therefore ask again whether this is a machine as seen from the top or from the side I would be very pleased to get some information on this subject, as I am ashamed of not having understood everything you said.

Neither did I understand Fig. 31. However as a compensation I want to tell you that two American inventors made the announcement that they have designed very light engines. One, Mr. Maxim, says that his engine (internal combustion) weighs 2.72 kilograms per H.P., and the other Mr. ^{Langley}Parmenter has a gas engine which weighs 1.18 kilograms per H.P. I am sending you a newspaper article which gives a sketch of the latter. I believe that three quarters of these claims may be discounted. Yet even if it weighs 5 kilograms per H.P. your motorized airplane is very close to being realized. I have been promised some more details on this matter shortly.

Therefore please let me know whether you have obtained an equilibrium which is stable and automatic in every direction, as your letter seems to indicate, and (if this is not a secret) its principle. Yet I want you to feel certain that I do not want to pry into your invention. I have some means and would like to see my name be associated with the conquest of the "empire of the air", but I do not want to expose myself of being accused to have appropriated the ideas of somebody else. This is the reason why I have been hesitating to decide what I could do with the various devices you proposed for our World's Fair. Almost all of them are what we here call "inventions on paper" which means inventions which are not yet perfected. This type of idea is not only hard to sell but very easy to steal. However I am willing to consider some of them under the following conditions:

1. You to take out a preliminary patent if this is possible. If not, you to explain to me the idea in every detail so I am able to judge its possibilities. If I do not accept it, your secret will be protected.

2. If I accept you are to state a minimum price, I am to take care of all expenses and I am at liberty to take in associates for the exploitation. You are to receive one half of the profits.

3. If I myself am unable to decide whether any of the ideas merit consideration without consulting experts, I shall not consult anybody without your special permission. However if this should be the case the risk of indiscretion is yours.

Following are the ideas which in my opinion are easiest to make use of at our Fair:

- 4. Alpine balloon for an exposition
- 6. Dirigible balloon without propulsion device
- 7. Mineral sorting device using very little water
- 8. Dew condenser - a complement to the preceding device

It may be perfectly possible that with more explicit information I could raise some money for the other ideas especially if they are in such a stage that they may be patented. It seems to me that you could patent and sell the following in Europe:

- 1. Constant propeller of higher efficiency
- 3. Look-out post for the Navy
- 9. Balloon valve
- 10. Torpedoes for the Navy

I believe that you would get less for them in America, because less attention is paid in this country to matters pertaining to war.

You may be interested to learn that you have converted Mr. Drzewiecki to flight without flapping wings. He wrote me from St. Petersburg that he has just put the finishing touches on a book which deals with this subject. He is going to go to Paris where he wants to build an engineless airplane.

Mr. Langley the Secretary of our "Smithsonian Institution" or Museum of Arts and Sciences asked me to tell you that he has read your book with great interest. He says that he shares your ideas and that he would be glad to be of assistance to you.

Your very devoted

O. Chanute

31 December 90

P.S. Rereading my letter I notice that I have not thanked you for the explanation you gave me on the way in which a bird attains an abrupt change of horizontal control. I want to make good for this oversight by thanking you very sincerely for this interesting observation which should be of real importance when air navigation becomes a fact.

I notice also that I told you to protect you so that your ideas may not be appropriated either by me or by somebody else. I advised you to have them patented before divulging them to me, but I have not provided for the money you would have to spend to do so. I therefore am sending you 500 Francs which you may either use for this purpose or else to have copies made of the papers and the explanations you want to send me.

There is a passage in your letter of June 14th which I have not quite understood, probably due to my lack of perfection of the French language. You said: "Dans L'Etre parfaitement doue pour le vol, ou la nage, le trainement peut etre neglige". By using the word "trainement" do you want to say friction or else total resistance? In the latter case we are directly pushed back to the dirigible balloon which however is not commended by you.

I am also very anxious to know what you have actually found out about tailless kites. So far I am acquainted with the Japanese kite or rather the Chinese kites, the military kite

And the Bazin kite

They all are based on the same principle and I wonder whether you have discovered a better form.

Your very devoted

O.C.

Cairo 31 January 1891

Mr. O. Chanute
Chicago

Dear Sir:

I received your kind letter of December 31, 1890 which contained a draft of 500 Francs made out to my order on the Credit Lyonnais. This amount is for the purpose of taking up arms and guard myself against you.

Now, I have no words which could express my thanks to you. Whatever I might say would not be adequate. I shall not take out any patent at all, and you may reverse this decision in case that there is something which may be profitable among the ideas which I am submitting to you.

I therefore accept with gratitude the conditions which you stated in your letter. You do the best you can, and I am certain, in advance, that everything will turn out for the best.

My poor book, which only lacked one chapter from being finished, has to wait now a while before it will be published.

I herewith enclose a photograph of your servant. I am taking the liberty to send it to you, as it may assist you to form an opinion of the person with whom you have business dealings.

Here also is some information about myself.

I was born in Lyons in 1835. My Father was a manufacturer of silk kerchiefs. I was a pupil in a boarding school until I was eighteen. From there I went to the School of Fine Arts in Lyons and then to that of Paris. Here I stayed two years and became a pupil of H. Plaudrin, a painter of religious subjects.

This master as well as art itself did not agree with my temperament. I had made a bad choice. Finally, when my entry into the competition for the Prize of Rome was denounced, I left Paris, quit painting and went to Algiers where I bought a large farm.

However two blows struck me there from which I did not recover: An epidemic among the farm animals, and monetary losses pretty nearly ruined me, I must confess. As this was the time of the general flight from Algiers (1865), I did as everybody else, I left and settled in Egypt. I was admitted by the Egyptian Government, as professor of drawing at the military schools, and kept this position until 1871. At this time every Frenchman was dismissed — Paris had fallen.

Since then I have been a merchant with various success, and at present I am a druggist.

It so happens that I am back in the trade which I had a chance to learn until I was 25 years old. I was a hard and conscientious worker, but very irregular. My small means allowed me to do this, and I never supposed that my "wings could be clipped". Neither did I want to qualify in this special business, a matter which I truly repent. I was already stricken by that horror of beaten paths which has been the misfortune of my entire life. This is the reason why there are so many gaps in my knowledge although I know so many things.

Here then, Dear Sir, you have the true picture of the man in whom you wish to interest yourself. I am going to prepare the documents and to send them to you as soon as they are ready.

Finally, Sir, I have to thank you for the confidence and sympathy which you so kindly showed toward me and to tell you that I shall not forget it.

I am, Dear Sir, your very devoted

Mouillard

9 February 1891

Mr. L. P. Mouillard

Dear Sir:

I am sending you a pamphlet which has just been published. In it is reprinted a paper I presented at Cornell University last May where I tried to describe the actual status of the aeronautical problem. Unfortunately this pamphlet is in English. You may note that I expressed the opinion that in the very near future it will be possible to attain a speed of from 60 to 80 kilometers per hour with dirigibles equipped with conventional engines. However when higher speeds and heavier loads are desired the airplane must be considered.

I mention your book on page 26. Then I analyze the work of Mr. Drzewiecki and point out that airplanes will probably require engines of about $1/4$ H.P. per ton per kilometer/hour. This means that if the machine weighs one ton and the known speed is 40 kilometers per hour, we will have $\frac{1 \times 40}{4} = 10$ H.P. as a maximum.

Taking this as a working basis, I calculate that 1 H.P. should not weigh more than 23 kilograms, and I examine the weight of present-day engines 1. steam, 2. gas engine and 3. electricity (page 31), giving due recognition to the latest studies on gas engines. Since I have given this lecture two American inventors announced that they had invented light engines as I told you in my letter of Dec. 30. One, Mr. Maxim who says that his engine weighs 2.72 kilos per H.P., is a reliable man who intends to make some experiments in England; the other, Mr. Pennington who is at present here in Chicago told me that he experimented with a small gas engine which produced 1 H.P. at a weight of 1.1 kilos and that he is going to build a 100 H.P. in the same proportions.

When I inspected the model of his dirigible balloon which is supposed to make 40 kilometers per hour and which makes 4 kilometers per hour at best, I came to the conclusion that this man is a practical joker (a leg puller). He proposed to build for me a 50 H.P. gas engine which would only weigh 454 kilograms or 9 kilos per H.P. I shall look deeper into his proposition. The Society of American Civil Engineers honored me by electing me as their president. I am going to write to Mr. Maxim who is a member of our Society for a description of his engine as soon as his claims are covered by a patent.

I write you all this as a sort of information in reference to the pamphlet I sent you.

I hope you read English or that somebody close to you will.

O. Chanute

19 February 1891

Mr. L. P. Mouillard

My Dear Sir,

I am very much affected by the candor and confidence which you expressed toward me in your letter of January 31. Your first letter aroused my sympathy and since then this sympathy has constantly increased.

I shall try to be worthy of this confidence which you are so kind to show to me, yet I urge you to take certain precautions so that all your inventions are clearly specified to prevent any idea of yours to be taken away from you. On the one hand I have known inventors who wrongly believed themselves to have been robbed, and on the other hand it is sometimes hard to distinguish between what is one's own invention and what has been suggested to you by somebody else.

I myself have some ideas which I believe to be new, but fortunately I explained them to a collaborator so I may lay claim to them if need be.

I am sending you my photograph. I was born in Paris in 1832, but I have been in the United States since 1839 so that I am a full-fledged American, even to the point of being prejudiced. I began my career as engineer in 1848, and until 1883 I have been constantly employed by various companies in the construction and administration of railroads and bridges. In 1883 after having acquired a certain amount of wealth I became consulting engineer. At present I am in the business of preserving wood by means of a chemical process and have an interest in a Chicago factory for this purpose. I am in a position to sacrifice 50,000 or even 100,000 francs in an enterprise which looks profitable. I also have some friends who have enough confidence in my judgment to advance me capital. However I want to be very sure of my statement before inviting them to invest.

I have always been interested in air navigation, but only since there is no more objection on the part of my family did I take it up actively.

With a cordial handshake, I am

O. Chanute

Cairo 25 February 1891

Mr. O. Chanute
Engineer

My Dear Sir,

By the same mail I am forwarding to you a part of the manuscript of my book "Le Vol Sans Battement". [Flight Without Flapping Wings]. After you have read it, kindly return it to me. I then will mail you the continuation of it, and by doing so I shall have time enough to re-examine and to repeat experiments which date back a long time. At present I am experimenting with parachutes and kites; therefore these will be the two subjects which I shall submit to you first. My propeller and my high-speed boat cause me much trouble; however I hope to overcome it and to be able to present them to you in a comprehensive manner. With the part of the manuscript I sent you today I believe that I shall convince you of the possibility and the necessity of gliding flight. All you need is a demonstration and to see the models. I dare not hope to be able to show them to you. The exposition date is approaching and I know well that I must not insist or else you would not be able to carry out your duties.

If during the exposition you think it necessary to make a test of aviation by the method mentioned in my manuscript and in case you want to build one of the airplanes described therein, you will have my wholehearted consent, and I only wish one thing, namely that this test turns out to be successful. However success not only depends on the machine but also on the aviator. It is unfortunate that I cannot carry out these experiments myself, my knowledge of the flight of birds would simplify this problem very much. I have tried hard to explain everything I know, but I recognize that it is almost impossible to do so, especially in writing.

Finally, Sir, I have appointed you as judge to do the best you can, and I shall abide by your decision.

Please accept, Dear Sir my most cordial greetings.

I am your very devoted

Mouillard

Cairo, March 15, 1891

My Dear Sir,

I have just received your kind letter, also your photograph and I thank you immensely for them. Your previous correspondence permitted me to guess many things, among others that you are of French birth; now I have absolute confirmation and I like nothing better than to tell you that I am going to continue to recapitulate, wholeheartedly and without any reservations whatever, everything I believe to have dreamed. I know things will be in kind and firm hands. I therefore rely on you absolutely.

Enclosed is a description of my ship, the one I have brooded over since I was a youth. It is only expressed in words yet I have it very complete in my mind: a new log, lubrication of the bottom, etc., nothing on it is missing. What gets me somewhat afraid is the revolutionizing part. I do not know whether one may risk it; I fear it is too far ahead of the times. My only hope is the daring of the Americans. — Two weeks ago I mailed you those chapters of my book which pertain to direct aviation. I hope they have reached you. This is a record of observations of my life-long observations. I had a great advantage over those who applied themselves to this problem, because for thirty years I have had excellent models constantly in front of my eyes. It is to this circumstance that one must attribute the exuberance of my faith, the certainty of being right that radiates from every page of my book. This is no boast on my part at any rate as far as I personally am concerned, as it is the bird the master flyer, which I defend. It cannot speak and I feel as if it had chosen me as its interpreter.

I have read, dear Sir, the best I could "Aerial Navigation" and the other English reading matters you sent me. I have to confess to you my ignorance in regard to languages: I do not speak either English or German or even Italian. This may be traced back to a deficiency of the brain which all Frenchmen have when it comes to learning another language but their own. By the same token I am in Africa for thirty years and I speak Arabic very badly. And we are all like that, at least when we are confronted with a study which we should have taken up when we were young. I am expecting a friend of mine who is going to translate everything for me from A to Z, and as soon as I have digested it I shall chat with you about it.

May I ask you, Sir, to have the kindness to convey to Mr. Langley who showed such great interest in myself and in my ideas, my respectful regards and to thank him for his amiable kindness shown toward me.

I remain, dear Sir,

Your devoted
Mouillard

20 March 1891

Mr. L. P. Mouillard

My Dear Mr. Mouillard,

On the 16th of this month I received your kind letter of February 25 and I have just received your book by the same mail.

I was not expecting anything else in the package but a summary of the inventions you mentioned, and I am quite uneasy to have on my hands a document which is so important to you. I hope you have kept a copy of it, in case of loss in the mail. At any rate I shall take good care of it, keep it in my safe, and return it to you as soon as possible.

There may be a possibility that I have to retain it for several weeks as I have to go to Washington where I am to speak on the occasion of the Hundredth Anniversary of our patent system.

As soon as I have examined the material I have just received, I shall write you again. May I suggest that you send me in the future first of all those inventions of which you think I could make some profit for you. I long for a chance to be active in your interest.

With a very cordial handshake, I am

O. Chanute

Chicago
7 April 1891

Mr. L. P. Mouillard

My Dear Sir,

The day after I received your manuscript I took sick with the grippe and as soon as I felt better I opened "Le Vol Sans Battement". I was thrilled and I read it from beginning to end without stopping.

I shall come back to it when my head feels more at rest, but I want to give you my first impression.

You did a remarkable piece of work, and I hope that the principle on which you base your theory — that it will vary the center of gravity in order to change the angle of attack — will lead successfully to gliding flight and perhaps also to powered flight.

I wonder what benefit you may draw from it, and I suppose you want two things:

1. To have the honor of having advanced a fine idea.
2. To draw some pecuniary profit out of it.

It seems to me that both could be combined by taking out a patent first for the principal applications of the idea and then by publishing your work so that the amateurs begin to make experiments. Lest we deceive ourselves, there are many tests to be made and mishaps to be endured and this may take a long time. As you admitted yourself, your machine with a 23-meter span is not very practical and a long way off the basic idea to be put into practice despite of this idea being so simple.

Yet basic ideas cannot be patented, the law protects only their applications. I therefore urge you to think of some relative combinations which could be made with your idea, and of the claims to be applied for in a patent. There is always the peril not to think of every application and this is a delicate point on which you have to take chances; because I am thoroughly convinced that once your book is published the simplicity of your idea will induce many people — I to be the first one — to build machines.

If you so desire, I shall defray the expenses for taking out patents as soon as you are ready to do so. Also, if you give your permission, I shall translate your book so that the French and English editions will be published at the same time.

I deferred from going into details of your machine until I had received your book. However I would like to know forthwith which is the angle of attack the soaring bird uses more often against the wind and whether it is inclined to the front or the rear.

With a sincere handshake I am

O. Chanute

(4 April 1891)

(Letter from Mouillard to Chanute - Lacking.)

April 8, 1891

Mr. L. P. Mouillard

My dear Sir,

One hour after I had written you yesterday I received your kind letters of the 15th, and I read them at once.

I must admit that the form of the hull which you praise so highly has surprised me. I have investigated birds and fishes and I thought that the main beam should be about $1/3$ from the front so that the streamlines in the rear could render a part of the work needed to produce a compression on the front, as shown in Goupill's Locomotion Aerienne pages 25 and 89.

Yet I know that experiments with torpedos show that for high speeds the main beam should be about $2/3$ from the front, and that for pleasure boats the same form as you proposed is used in America.

I am sending you the first booklet on this subject which I could lay my hands on. It is from the Douglas Co. whose place of business is several miles from here. See pages 38-40-46-48-97 and 99.

The flat hull is excellent and is much in use on our rivers, but the deep keel has a great handicap, because there are very few ports where a ship which has a draught of 10 meters could enter. Most of our harbors have from 4 to 5 meters at best. Fortunately we have invented the movable keel, a flat hinged plank which acts as a keel in deep water and which is retracted into a hollow space provided for it on the hull, if the ship is in shallow water, see pages 19, 26, 31, 33, 53, 58, 64.

Do you think of attaching propellers to a series of false keels, as I have indicated with pencil marks on pages 26, 31, 33. Either the propeller has two blades and is retracted against the true keel, or else it has 3 or 4 blades and is retracted into a hollow space provided for this purpose which has shutters equipped with elastic hinges in order to preserve the smoothness of the hull.

The Americans certainly will not be afraid of your idea. It remains to be seen whether they think of it well enough to try it out. I therefore must explain the matter to experts under promise of secrecy. I intend to do that as soon as I can do it with caution. I see already that this means giving away a good part of the patent in order to induce the designers to make experiments and to build a ship. Yet this is just what is needed between England and France.

With a handshake I am

O. Chanute

Cairo
April 14, 1891

Letter from L. P. Mouillard to O. Chanute - Lubrication of Ships.

MISSING

24 April 1891

My dear sir,

This morning I received your kind letter of April 4, and read it with great interest.

For two months I have been wondering what an "Alpine Balloon" would look like, and now you come and have reinvented an old acquaintance of mine. The idea is not a bad one at that, but it needs to be improved.

In 1850 the American aeronaut Wise published a book in which he proposes a spheric balloon of a diameter of 5.50 meters from which a man who was equipped with articulated wings could be suspended. He could move the wings and his legs. He claims to have made jumps 100 meters long with the wind in a similar machine, also to have crossed a pine forest several kilometers wide by jumping against the tree tops.

However experiments soon demonstrated that a slight breeze would carry off the machine and the aeronaut. In fact a wind of 10 meters per second produces a pull of more than 100 kilograms on a sphere which has a diameter of 5.50 meters. This is more than a man could do, so the idea was abandoned. Several years later this idea was taken up again by the English author Mansfield who was acquainted with Wise's experiments. He proposed a spindle-shaped balloon (approximately 24 meters x 4 meters) from which a man was suspended by means of a harness and so could use his arms and legs to create forward motion. I do not exactly know why the experiments were not successful, but I believe it was due to the wind and to variable gusts which struck the balloon on the sides.

An American aeronaut, Carl Myers, who probably knew of these experiments for several years, had the idea, that it is necessary to make use of the wind as the birds do, instead of being carried off by it. About three years ago he started experiments with a sphere cut in two, and he is about to improve a machine which he calls "Aerial Bicycle". Vague mention of it was made from time to time in the newspapers, but on April 11, I found in my paper a detailed description which I am sending you together with a translation which I made especially for you. I also am mailing you the only illustration I have of it, which I clipped from a funny story about two months ago. I believe that the experiments are not yet entirely completed and that the inventor has not taken out all patents pertaining to the machine, so that there are some gaps in the article as well as in the illustration. Yet I think you will be surprised to note the progress made, and with a machine which moves against the wind.

I know another American inventor who, about two years ago retired into the desert so he could make experiments. He wrote me that he at last had produced a machine without balloon, which rises and moves forward against a strong breeze, but that its equilibrium is not stable enough for him to make an ascent in it in person. As far as I know he uses a curved surface, reproducing the forms of a wing in an approximately square plane.

Therefore, the question is, to know whether you would be able to improve your idea of an Alpine balloon in the direction indicated by these American experiments. If so, I shall make some tests here at the opening of the exposition to improve the matter before showing it.

It seems to me that the form shown in the illustration is not the best possible and that the lateral equilibrium leaves much to be desired when exposed to gusts.

The machine ought to be very slow and if possible should be provided with a tricycle gas engine. This engine could blow gas into the calotte once the take-off is made, which would prevent the calotte from fluttering out and so reduce drag. The engine also would supply the motive power.

I have not yet consulted the experts in reference to your ship, but hope to do so within a few days.

I shall be glad to get news from you and remain with a cordial handshake,

O. Chanute

Cairo
May 5, 1891

Letter from L. P. Mouillard to O. Chanute - about airplane and its dimensions - MISSING

Cairo
May 14, 1891

Letter from L. P. Mouillard to O. Chanute - Alpine balloon - MISSING

Cairo
May 25, 1891

Letter from L. P. Mouillard to O. Chanute - about log (idea for Exposition) MISSING

Cairo, June 17, 1891

My dear Sir,

As much as I fear to trouble you, it seems to me that waiting much longer would make me look indifferent.

I have not had any news from you since I received your kind letter dated April 8th. I hope, I even am convinced that nothing unfortunate has happened to you. Perhaps your many business activities do not give you time to think of me. Yet, I beg you to please send me a short note just telling me that my dear benefactor is in good health. As long as I know that this is the case, I hardly worry about everything else and am at ease.

Permit me to describe to you the sensation I experienced just a few moments ago. I was on the threshold of a door when I noticed two or three large vultures which flew majestically from South to North. When I saw these uncommon birds I was rendered immobile by this spectacle. I studied then that mode of flight which is the non plus ultra an aviator may dream of, when I saw several others arrive, flying like the first ones toward North. I told myself that here is a good opportunity for me to verify whether all I have written about this almost unknown bird had not been exaggerated, but when I looked at the picture, the photography of the spectacle it offers I had to admit that I had only transgressed by my inability to know how to present what I had seen. I still was there with those thoughts when I noticed far away a flight of more of these birds coming this way. They advanced slowly, yet with a speed which other birds could not attain without flapping their wings. Several hundred have passed above me. This is one of the greatest mass flights of these birds I have ever seen. I thought, if Mr. Chanute was here now gliding flight would be an accomplished fact. One does not need to look twice to be convinced. While they passed above me for twenty minutes I noticed once more their flight, so extraordinary by its simplicity, and was satisfied that what I had just seen was a fine performance. If I were free to act I would have jumped into a carriage and would be at that spot in the desert where they are now. The sight which they must present ought to be an entirely different picture than that I tried to paint of them in flight-without flapping wings. They have lured away all the small vultures of the city. My own have left with the rest.

It is too bad that I have no other point of observation, as from the street where I am now one has only a very limited one of the sky. I am told that these birds are coming from every point of the horizon and fly toward Abbassieh and there must be thousands of birds in that locality.

I know what attracts them! Tomorrow the caravan which carries the holy carpet to Mecca sets out. The pilgrims and their mounts are assembled in this section. If I had left at the time I wanted to follow the birds I would have been forced to make several kilometers more, because they are above Khoule's which is farther away. But this is a trifle to them. Yes, dear sir, I observed carefully, analyzed well and I am even convinced that I have not been mistaken in the explanation and imitation of this type of flight. I am correct, these two hundred or three hundred vultures have proven it to me for the thousandth time.

I consider myself in a very disinterested way. It does not seem to me as if it was I who had written "l'Empire de l'Air", it is so long ago since I read it the last time. The same holds good for "Vol sans Battement" except the last chapter, so I am entirely impartial.

I am telling you all this in such a lengthy manner because I am enraptured. Among all these birds I have not seen a single one flapping its wings, and they flew against the wind. You may judge now what I think of flight with flapping wings.

My very dear sir I shake your hand affectionately and call myself your devoted,

Mouillard

P.S. Have you received my rotation indicator?

June 19, 1891

Mr. L. P. Mouillard

My dear Mr. Mouillard:

For the past two months I have been mostly out of town, in New York and in the South, so that I owe you an answer to four letters, dated April 14, May 5, May 14, and May 25. I therefore shall make four separate replies, as short reckonings make long friends.

Let us take up first yours of April 14th. I am sorry that I did not receive it before my trip to New York where I wanted to get some information about experiments which have been made in reference to lubrication of ships. I know vaguely that they have been made but do not know under what conditions. It has been said that the ship officers tested various materials and that yellow beeswax has given the best results. The coefficient of friction resulting from one application of it was less than that of a film of petroleum. However, it is necessary to inquire more fully or else one would run the risk of being frustrated when taking out a patent.

I want to tell you that your "Lubricator" looks to me to have a greater profit-making possibility than all the other ideas you have yet presented to me, provided that the idea is a new one, and the effect such as may be expected. It is simple, practical, not expensive and easy to demonstrate. If this is successful there would be a nice profit on it, provided one is not robbed by the ship owners. In order to prevent this it would be necessary to take out patents and to have inspectors in every maritime country.

I am not so impressed with your "Insufflator". Air is so much lighter than water that it will rise to the surface without decreasing friction very much. It would be necessary to pump it in along the keel in order to get an appreciable effect. In such a case the application would not be easy on a ship in service and then maintenance has to be considered also. Yet one could make experiments.

My idea for the moment is to get some information on what has been done about lubrication, then if action has been taken, to take out patents unanimously. After that to arrange a transatlantic trip at my expense to make the test. If three hours can be saved between New York and Liverpool the business deal is as good as closed. During my travels I have visited the Douglas Co. in reference to your ship. I was told that beginning with the shape of the "Nimrod" page 97 and "Nabel" page 99 they have already come very close to the hull you propose. Also, that this shape is very good on calm water, but wretchedly bad in rough seas for the waves rush underneath the ship and slacken in pace. Therefore it cannot be used for ocean-going steamers and is limited for pleasure boats only.

It was explained to me, how experiments are made pertaining to the form of ships. It is entirely empiric. Each time only one single part is changed in order to be very certain that the resulting effect is caused by this modification only. Yet this modification is never very extensive, because there is a possibility that it might modify the effect of other parts. What turns out to be good is being retained while bad features are relinquished. But the progress for the better is very slow, for ships have been built for such a long time that there are not many improvements which are not known. An objection is raised against your idea, as there would be too many new parts (deep hull, 4 screws, new pitch, special machines, means of transmission, etc.) too many chances to be taken when building on a large scale, and besides there are no harbors deep enough for 10 meters draught.

I believe that you have been told a similar story in Europe. The question now is simply to see other shipbuilders in order to get either a different opinion, or good reasons to believe that this idea would not be profitable at all.

Please give me your opinion on the subject of the effect of waves on the hull proper. It may very well be possible that the form of a diving bird is not the best for a floating ship.

Do you know of a speed fish which has a shape similar to the one you propose?

It seems to me that the front part of this type of fishes is very large, so that the lines of the fluid flow (stream lines) when they come together again in the rear assist to a certain extent in their separation on the front.

At any rate, I am going to look for more information and I shall follow up this matter by trying to find somebody who is willing to make experiments, even on a small scale.

With a sincere handshake, I am

O. Chanute

June 20, 1891

Mr. L. P. Mouillard

My dear Sir,

I wrote you yesterday in reply to your letter of April 14, and today I want to answer yours of May 5 which deals with the question of the airplane.

In a few days I am starting to translate those parts of your new book which you submitted to me, then I shall return them to you.

I have engaged somebody to translate "l'Empire de l'Air" under my supervision in order to expedite matters.

I have decided to make large-scale experiments with your airplane and I have found two men to assist me. One is a young engineer of my acquaintance, who has aptitude and knowledge for this kind of work and whom I shall put to work; the other is a strolling photographer who for the last 20 years has observed the flight of birds. He has built several small airplane models which resemble yours very much. Naturally I shall not show him your designs, in order to protect your priority, and if I make an arrangement with him, it will only be to experiment with him on his machine, before starting with yours. His idea is to suspend the airplane by means of a steel cable which is held between two posts which are about 60 meters high and which are placed about 20 meters apart. About 15 meters above the ground the airplane will be put through its maneuvers, the pilot lying flat on his stomach.

His machine has three adjustments. The cane in front - aa' - is rotary and increases or decreases the margin in the front, cane - bb' - which is strongest, is hinged at - b'b' - to displace the center of gravity, while the tail is pivoted by means of a universal joint.

It is confronted with the same difficulty, which I notice on your machine, namely, when a ratio 1630 grams per square meter is adopted the machine would not have enough resistance in consideration of the light weight necessary. I showed him the superimposed planes but he fears that such an arrangement would interfere with the maneuver to circle in the air, a motion which he proposes for climbing.

I am sending you a newspaper article which gives a description of Maxim's large airplane. He proposes to change the angle of attack by varying the position of the nacelle which is suspended underneath by means of adjustable ropes. Seen from the side, it will look something like this:

not a drawing

Here you have then two methods a little different than yours for changing the position of the center of gravity. I therefore kindly ask you, in order to apply for a patent, to let me know:

- 1) The various ways which you have considered to vary the center of gravity and the angle of attack.
- 2) What practical construction do you recommend to make a test with your machine?

By being careful I believe that I do not need to fret about a machine of 2500 grams and even 5000 grams per square meter. It seems to me that the smaller a machine would be in proportion to its weight, the easier it would be to handle, and the equilibrium could be better maintained. At present I am looking for a patent bureau which understands the aeronautical problem well, so that I may get in touch with it.

As to the angle of attack I did not express myself clearly enough. I wanted to ask you whether the plane of the wings is inclined toward the front or toward the rear when the bird is circling. If it is inclined toward the rear the horizontal component force interferes with the forward motion. If it is inclined toward the front the horizontal component force acts in the direction of the motion. However, the bird will drop, unless the speed is high enough to lift more than the weight of the bird and provided that the wind does not add any weight on the back of the bird. In this case the angle of attack must be very small and a very delicate adjustment of the surfaces is necessary. This is my reasoning, and perhaps I can make it more distinct by exaggerating the matter. Suppose a wedge moves horizontally against the direction of the wind; it is clear that the wind does not add any weight on its top.

Let us represent the weight by the line OP, and the normal pressure by the line ON, provided the wedge moves with the wind. If we then construct the parallelogram of forces above the wedge and make OA equal to ON we notice that it is broken down at AB which assists the motion and at OB which balances the weight. But when the wedge moves against the wind with a certain speed the normal pressure increases and becomes ON' which is broken down at OD in the direction of the motion and at OB' in the direction of lift. Therefore the bird is lifted while advancing against the wind.

Yet the thicker the wedge is on the blunt end, the greater will be the resistance of the air at forward motion. There is then a delicate arrangement of surfaces to a very limited degree, with a very special curved profile in front which you call "aspiration".

I shall be glad to have your opinion on this subject, and for the present I kindly ask you to preserve for me the secret of this theory.

With a handshake I am

O. Chanute

June 20, 1891

Mr. L. P. Mouillard

Dear Sir,

This morning I wrote you in reference to the Airplane, and this letter refers to the Alpine Balloon, in reply to yours of May 14.

You are perfectly correct with your remarks on the aerial bicycle. During my trip I visited with Mr. Myers and I found out that the newspaper reporter acted very much on his own.

Mr. Myers (he calls himself professor as a matter of form) is a practical balloonist who charges an admission fee for his ascents. His investigations on the shape of least resistance are made during his spare time. He has given up the hat shape, I wrote you about, and has applied for a patent on the enclosed form. He has used it six times in public and succeeded in moving against a wind of from two to three meters per second.

He does not claim at all that his balloon was moved forward by the opposing wind. He discussed with the reporter several experiments with tailless kites. These kites moved against the wind when the string was cut. The newspaper had the balloon and kite experiments all mixed up. Besides the outcome of the experiments with kites as mentioned before, were purely accidental and he cannot give any correct explanation of what took place in the air. He certainly is not able to repeat such a performance. The only explanation in this case could be that the kite moved against the wind while descending and it is easy to explain that the action produced was due to fact that the equilibrium became stable.

I am expecting your chapter on kites with great interest. I have been in Washington to see a score of machines of this type from China and Japan.

I have decided to build an Alpine balloon for preliminary experiments and I kindly ask you to send me the drawings and instructions which you deem necessary. I do not think that I need any for the balloon and the net, but there is a possibility that I might make mistakes as far as the airplane and the harness are concerned.

What do you think of using a fish-shaped balloon instead of the sphere you suggest? The wind is an obstacle to be reckoned with, as there will be very few days when the air will be calm enough so as not to carry away the sphere. The latter has a coefficient of 41 percent of the surface at the equator while commandant Kinard's balloon has only a resistance of 18 percent. Besides, one could do better yet.

My calculations show a pull of 30 kilos on a sphere of a diameter of 5.50 meters by a wind of 5 meters, and only 9 kilos by the same wind on a spindle-shaped balloon of a diameter of 4.87 at the equator.

Yours as ever,
O. Chanute

June 21, 1891

Mr. L. P. Mouillard

My dear Sir,

I wrote you one letter on the 19th and two on the 20th, and today I am going to answer yours of May 25th in regard to the log.

I feel not competent enough to express an opinion on this device and shall have to consult experts. However, I would appreciate if you would write me a short note telling me its practical applications, and the necessity which led you to its invention. You see, I do not understand.

Let us take up once more the subject of experiments on high speeds. I am sending you two issues of "Electric Power" which give a report of them. On page 130 of the April number is a description of an arrangement with which speeds of 185 kilometers per hour have been attained. The closed curved track was about 3 kilometers long and its gauge was 71 centimeters. The framework was of wood and had on its upper part a third rail, head down, which guided an upper wheel to prevent oscillations. See general view. - The car weighed 3 tons, the driving wheels were outside and the dynamo inside. Electricity was supplied by means of the top rail. Fig. 1 shows the side view, the section and the top view. The engineer estimates the air resistance to be about 72 kilos per square meter, at a speed of about 242 kilometers per hour. This would give approximately a coefficient of 13% for the resistance of a thin plane.

The car was 5 meters long, 71 centimeters high, and 76 centimeters wide. The diameter of the wheels was 71 centimeters. The experiments were made with cars of various shapes and had the principle purpose to build a railroad for the high-speed transportation of mail. Later on it is intended to develop this transportation into passenger service.

The June number brings on page 215 a report of an experiment of an entirely different method. The electric motor instead of being inside the carriage, consists of a series of rings which are electrified in succession and attract a carriage which is mounted on internal wheels, either above or below and contains mail. See the track page 216 and the carriage page 217.

The carriage weighs 227 kilos, is 2.50 meters long and has a diameter of 25 centimeters. Both ends are pointed. The experimental circular track measured 849 meters and the speed obtained has been 54 kilometers per hour, at which the air resistance was about 1/2 kilo. The speed expected in practice is also 242 kilometers per hour. However in neither of the two experiments was the track built solidly enough to allow such a speed without danger. The experiments should be repeated on more solid tracks.

I wish to submit to you the following question: Which is the best form the carriages should have to meet the least air resistance?

With a handshake I am

O. Chanute

There is no hurry about the answer.

July 12, 1891

Mr. L. P. Mouillard

My dear Sir,

I received your letter of June 17 and by now you should be in possession of my 4 letters of June 19, 20, and 21, which tell you why I have not answered sooner.

With the greatest of interest I have read your description of the flight of the great vultures toward Abbassid and I wish deeply that I could have enjoyed the stirring spectacle of this flight which appeared so extraordinary by its simplicity. Did you notice whether the birds descended while flying against the wind or whether they stayed in the same height?

While we are on this subject, permit me to ask you what you mean by "great vulture"? Is it brown or grey and does it eat fresh meat or carrion? In the southern states we have the turkey buzzard which eats rotten meat and which comes north during the summer. This is a grey bird with brown speckles. We also have in California a large vulture which is dark brown of approximately the color of the eagle, but I do not know its habits. If you would be kind enough to give me the necessary information I shall make it my business next winter to observe the flight of whichever of the two birds you recommend.

As I told you in my letter of June 20th, I engaged a young engineer in order to build a flying machine. At present we are experimenting with the longitudinal equilibrium which always gives me much trouble. Experiments indoors with the load in front and the correction fold in the rear do not always succeed in the open, due to strong breezes.

In the "Vol sans Battement" you say that no control is shown on the machines pictures in Dieuaide's "Tableau d'Aviation". Should there not be an exception in favor of those of De Temple (1857) and d'Esterno (1864)? It seems to me that both are gliders on which the carrying surfaces may either be moved forward or backward which causes a variation of the angle of attack. This may be of importance when patents are to be taken out.

In a few days I am leaving for the country where I shall translate the "Vol sans Battement" in order to return the manuscript to you. There is so much interruption in the city that I am unable to make any progress.

With a handshake I am,

O. Chanute

July 12, 1892

Letter from L. P. Mouillard to O. Chanute- (explains rotation indicator)-
MISSING

July 16, 1891

Mr. O. Chanute, Engineer

My very dear Sir,

I wrote you on July 12 giving some explanations of the rotation indicator. This is in reply to yours of June 19. My letter of June 17 must have revealed to you that I was worried. I could not imagine what had happened to you. I began to recite as the Mohammedans do "God is great!" I am happy to know that you are in good health.

I am of the same opinion as you about the profitable possibilities of the "lubricator." Just for fun I could send you my compliments for that little idea, which as a matter of fact is rather simple, but practical and as far as I know has never been utilized. Steamship lines do not have it on their large ships on the China route. My belief is that it is new.

It should not surprise you at all that a landlubber should have new ideas on matters pertaining to the sea. In my opinion it is just the opposite. When you are a sailor you finally get used to the sea; you do your job and finally think of nothing else. It is the same feeling I have with Oriental picturesqueness; I don't see it any more; I would not be able to describe it; I am oversaturated with it; it comes to my mind only when I am in France and forget it. Having said that, let's get down to the beeswax. I do not have faith in it because in a pure state it is hard to apply on iron and peels off in large sheets; when it is changed into a paste by the addition of a solvent (essence of turpentine) it will not resist the current because the paint is easily soluble in turpentine. The ship would have to be repainted very often, which means dry-dock expense and deformation of the hull.

Crude oil which I propose is cheap and makes gliding (in water) easy, due to two characteristics: First its lubricating action and then its preservative action.

The constant manner in which it is applied to the hull, makes it a perpetual painting job, beginning the moment the ship starts to move.

Its application not only makes it unnecessary to put the ship in dry-dock, it also eliminates scraping and painting which are necessary after several voyages in order to maintain the speed of the ship. The oil abundantly applied should take the place of paint. In my opinion its outstanding achievement is to make the ship's trip to the dry-dock unnecessary. This docking always puts the ship out of order, as its rivets work loose when its keel and its stays are supported on special points instead entirely on all sides as is the case when it is in the water. Therefore this method has, vulgarly speaking, more back than front:...

As to the inspection you mentioned, which, between ourselves is very difficult to carry out, I believe that this difficulty could be overcome by selling the patent to a large steamship company. Such a company would be in a position to look after its priority. It is my opinion that such an action would save us much money and time. Above all there is plenty to do, for I am not through creating.

I need your reputation, your position, your discretion. An idea presented by me, an unknown, immobilized in his hole in Carlo, does not carry much weight. However, if introduced by you, that is entirely different; you will succeed easily where I should fail utterly. Therefore, at my opinion, one should go easy in the first transaction and spend only a little money for a while. As a matter of fact, I speak here of affairs which do not concern me at all as they come under your jurisdiction; excuse me for stepping over into your grounds. This suggestion was due to my eager desire to give the penury which ties me down, a bit of lubrication.

At the time when the idea came to me, a score of years ago, I thought of adding to the crude oil various substances which would have remained in a dissolved state. Among them was euphorbia resin which has the property to prevent rust formation on iron. But in view of the difficulties connected with such a procedure, and in consideration of constructing a device which is essentially practical I used oil just as it comes out of the well and simply filtered it to remove the sand. It acts better than refined petroleum, because it is heavier, takes longer to come to the surface of the water, and finally it contains many substances which have the same effect as beeswax but which are dissolved naturally in the oil.

Let us talk now of the boat. I am entirely of your opinion that it will be necessary to get information from other shipbuilders besides Douglas. It seems to me that he is not anxious to consider such a transformation. The construction of some small yacht does not offer enough profit to risk such an enterprise. In order to be able to utilize and venture the construction of this boat, interested parties of another scope are needed. What I mean is a larger concern which may have the courage. It should be sensible in doing so, because if the idea is good, profits may be expected which should eliminate a good deal of the risk of loss of capital. In reference of your remarks as to the enormous revolution my suggestions are to bring about: everything new, from top to bottom is, at my opinion, a chance of success. This is truly new, it's the correct unknown quantity, and this it is its quality of which an intelligent and daring concern which has sufficient capital for risking a try should not be afraid.

I do not adhere at all to the tonnage which I have indicated. What made me put 100 meters and 1000 tons in the design I mailed you, was the idea to have this drawing on a scale 1:100, in other words make a centimeter represent one meter. In this way estimations may be made quickly and easily, also the reading of the drawing, all calculations may be made by means of mental arithmetic simply by using a ruler. However, I am adhering to the proportional depth of the keel, which is the most essential part of this invention. However, when the tonnage decreases, the keel becomes less in proportion in the same way as the screws.

In this connection I ought to give you my idea of what I call "shock". It is the blow struck by a wave on a flat surface, to which Mr. Douglas called your attention. You noticed that there are two kinds of waves: small ones and big ones. A small wave is the disturbance of the water caused by ten or twelve small waves which follow one another. At my opinion a boat should be built able to withstand either one or the other of the waves. Consequently there should only be two types of boats, one which endures the small wave only and avoids the big ones: this is the small boat, for the Mediterranean it is about 50 meters long. The large boat which passes over the small wave and only considers the big one should in my opinion be not less than 200 meters long. All intermediate dimensions have to meet these two waves combined. Sailors who serve on steam ships will tell you that during stormy weather it is safer to be on a brig than on a steamer which is hundred meters long. The "shock" is not noticeable on either the large or the small boat. The latter is lifted by the small wave, it is rather small to yield to it, so as to be carried away and not to be struck by it. As to the large boat its weighty mass protects it from the effect of this shock because the small wave is unable to lift it.

In reference to this shock which for good reasons causes anxiety, and according to the above ideas, one would be in a good position to build an ocean-going vessel according to my method which should be about 70 meters long. The dimensions of the keel in my design are decreased proportionally so that it will not prevent an obstacle when entering a harbor. Such a ship will not be carried away by any of the waves, it will pitch severely but under good conditions, it will not roll. The speed may be slowed down a bit by these momentary conditions, but despite of it, it ought to be still higher than that of the actual mail boats.

In reference to the large ship - 200 meters - I do not believe it to be practical. Commerce has no use for such sizes and could not fuel them. In my opinion this had much more to do with the failure of the Great Eastern than a cow falling into the sitting room and the rivalries of the English designers who were jealous of Brunel. As a mighty war ship she was a great success. With such a size her stability should be very great as should be her other properties, such as speed.

Summing it all up, if a good small boat is required which performs well on the sea, it should not be more than 75 meters long, else one would be under the influence of the two combined waves which sometimes have some very extraordinary effects.

Dear Sir, read again the chapter on "penetration", as I do not know how to express myself better; there you will see that I do not believe in a good profile of fishes and he who eats them has precisely the form of my ship.

Therefore, I am entirely of your opinion: It is simply a question to call on other shipbuilders.

With a cordial handshake I am, dear Sir, your devoted,

Mouillard

July 21, 1891

Mr. O. Chanute, Engineer
My dear Sir,

I am extremely thankful for your kind offer to translate my two books. I am sending you under separate cover the larger part of the rest of "Vol sans Battement". In order to finish them, I am retaining the chapters titled: Balloons - of which you have already a portion, namely the Alpine Balloon. Final review, etc. As to the rest, you may get a clear idea of the arrangement of the book for the table of contents at the end of it where you will see what chapters are missing.

I kindly ask you to look at once, whether there is a possibility to make profitable use of some ideas expressed in the book, before it is published. In the package you will also find the chapter you requested on kites. Please consider whether it contains a workable idea, if so try it out and take the necessary steps. It is not necessary at all to ask for my consent, as this would delay the matter for two months. I have stated to you several times, dear Sir, and herewith do it again that anything you wish to do is alright with me. If you think it wise to take out patents, please do so under the name O. Chanute from Mouillard, make use of them as you see fit, and I shall be happy.

There is one chapter which I shall withhold until I get some information, otherwise I shall omit it. It deals with the experiments with captive balloons made by the navy in Toulon. I asked Admiral Aube for this information, but he could not give it to me. He died several months ago. If you could obtain this information for me you would greatly oblige me. This look-out station is one of some interesting points of another aquatic disturbance of my making which I could not finish. It is just as new and just as unimpaired today as it was ten years ago.

Please convey my fellow-feelings to the young engineer, you told me about. I shall watch with great interest the construction and tests of what has been the constant thought of my life.

As to the pictured airplane, I had to reread your letter, as I could not see the basic principle. Is it a flapping-wing airplane or a glider? The accompanying drawing resembles the sketch you drew in your letter.

You tell me that the surface of my latest airplane is too large. I only wanted it so for the first tests made in still air. It certainly has no bearing whatever on the design, but it has an enormous carrying capacity. By means of this first practice the aviator is satisfied that the air is supporting him. As soon as he wants to go a step further, trying to rise and consequently be exposed to the action of an air current of about 5 meters, a reduction of the surface will be necessary. This may be done on this machine in a very simple way: The new airplane is traced by means of very taut and well-fastened string and everything which goes beyond (the tracing) is clipped off the "bird". If the surface

is still too large, it is decreased again, whereby it may be noticed that decreasing the surface corresponds with increasing the speed. One should arrive at not more than 12 square meters of surface which means a span of 8 meters and a width of 1.50 meters which is a ratio of 5:1 and could be classified as a slow soaring bird. This surface is amply sufficient for one who knows well how to fly in order to be lifted and to ascend without flapping wings. The large vulture has not got as much of a surface, but knows how to use it! It is up to us to learn step by step by recognizing gradually the difficulties and getting used to them. This is the reason this airplane with the exaggerated surface was created, as this surface may be decreased gradually.

As to the two high poles for the experiments you told me about, they are the fad of Basin and Sanderval. I very often have argued with Basin about this method and I hope that he is gradually coming back my way. Nothing is better than freedom, a high hill and water into which one may fall without hurting oneself.

Maxim's airplane according to your sketch, represents the infancy of the art.

It is one of the many dirigible parachutes. I never have been very successful with this type of machine which I have tried out many times, even recently. The control requires excessive and constant attention. Furthermore the load is placed too far from the carrying surface causing terrific swinging motions which take place once the speed decreases and these decreases are perpetual during flight. It is a parachute which, like any other parachute, oscillates the moment it starts to glide instead of dropping. It is a hundred thousand miles away from an airplane even from an imperfect one.

When he wants to improve his system he must shorten the lever [arm], then he gradually will arrive at the airplane quite naturally, where the load is supported by the entire body of the carrying surface.

You want to know the various ways which I recommend to vary the center of gravity. I have presented three methods. The first is described on page 250 and shown in figure 30. The method is correct provided two gasket rings are used; however, I must admit, that I never was successful to build it light enough. I have this machine at my place, it weighs 28 kilograms, it should weigh half as much. It will be necessary to preserve the principle which is fine, since it is a copy of the structure of the large soaring birds: vultures, eagles, etc.; however, it has to be much lighter. The only material I know of, which could be used is aluminum, but in view of its price I have to give up this idea. The second method is shown on the de Massin-Biot airplane. Here is its history in a few words: Mr. de Massin asked me in 1882 for my latest combination in order to put it into practice. I gave it to him and he started to build. Several months afterwards the revolution in Egypt broke out and I stayed with him for a month. Here I saw the finished airplane, but its weight was enormous, as far as I can remember it weighed 32 kilograms. He never gave it a real test, and later on let

Mr. Biot of Paris have it. Biot made some changes which I am going to describe to you (see the photograph). He started out by moving the aviator's place toward the rear. This is a mistake! The load of an airplane must always be in front. As a result of this move he could not make use of the control sticks which you will notice on the front, and which I have marked by two pin holes. He replaced these sticks by two pieces of curved wood of which he takes hold. This change in itself is not bad as far as the problem of moving the wing tips forward or backward is concerned. But my control sticks produced an effect which he seemingly did not understand, and which was the main reason for their being just where they were, namely their ability to create horizontal control. Actually, by moving these sticks forward or backward vertical control is created, but when they are twisted by putting one across the other, they turn and so produce the possibility of horizontal control. These two bamboo sticks rested in iron sockets which enabled this motion. The torsion created the following effect: The bamboo sticks, instead of being straight were slightly curved. When in regular position the arc of their curve was in the plane of the wing. When, due to this torsion, one wing tip was raised, a plane was formed which was different than that of the rest of the wing which remained in its original position. The latter produced horizontal control.

You understand that by this simple suppression it is deprived of one of the two directions, as shown in the photograph, and the airplane can be made to ascend and descend at will by moving the wing tips forward or backward, but it cannot be moved to the right or left. So Biot did not understand half of the mechanism which produces aviation. In spite of this basic imperfection he wrote me that he flew his plane, this may be so, but he never informed me that he had renewed his attempts. Moreover this machine was a copy of the structure of large soaring birds, it operates on about the same principle as the previous one. On both the displacement of the wing tips, though the manners of actuation differed, produced the same results of horizontal control. This control which is not presented in "L'Empire de l'Air", fig. 30, see the missing space and let us admit it, for the very good reason of a reservation which I have charged to my credit: a mistake on my part which makes the airplane incomplete. Because the action of the displacement of the aviator is insufficient as I have stated in the chapter "Horizontal Control" of "Vol sans Battement" and described in the artificially created plane by means of the torsion of curved bamboo sticks on the Massia Biot airplane.

The method which I explain in "Vol sans Battement" which is the latest one developed and consequently the one I recommend because of the facility of light construction is a copy of another bird type. It is the reproduction of the structure: swift, swallow, frigate bird. The wings are shown singly instead of both of them. Both directions are a complete action. See chapter "Airplanes" of Vol sans Battement, and you will find there all necessary construction details.

This is the method which must be tried out. The delicate points are the harness and the equilibrium of the tension of the rubber bands. Build it with a surface as large as possible. The size will be indicated by the characteristics of the materials you use. If you have aluminum use it, instead of bamboo, for similar conical tubes. If there is a proper solder actually available, which I do not know, fig. 1 could be produced by means of soldering a bent rod at the points A and B. If not, rivets may be used as shown in fig. 2.

Fig 1.

Fig 2

I have touched aluminum twice. On a small scale I have some trinkets of this metal; it is as resistant as iron and light as porcelain. It is the metal for aviation. I also have seen it in Paris at the Aluminum Co. There I have weighed large pieces. Their weight is extraordinary light. One is conformed when one lifts them. And to think that I have not been able to make use of this marvel: 80 or 120 francs per kilogram, I do not remember exactly which. This is the only disadvantage of this metal. The Aluminum Co. buys it back at approximately the same price, provided it has not been soldered. Nothing is easier for them than to cut down the price if one wants to resell it. In case you have no bamboo on hand, I cannot recommend this metal too highly to you. The two control surfaces of the airplane which are the principal parts, would not weigh more than 5 kilograms or 2.5 kilograms each at 14 meters for both. It could be built completely with less than 10 kilograms of aluminum. The weight of the silk covering is negligible. No matter which method of construction you employ, try the airplane, before finishing it under the load of the aviator. Then, when you are satisfied with the lifting power and you have the airplane completed, investigate the effect due to the weight of the operator on the carrying surface, before testing the machine. For this purpose I refer you to the paragraph "Form of the airplane under pressure" which I recommend you to make use of, to enable you to arrive at something important in the carrying surface.

These various machines, especially the latter, represent exactly flight without flapping wings: rigid wings cannot flap. I never heard it said that one had dared to apply for a patent on a rigid airplane; i.e., one which is unable to beat the air with its wings. It is up to you, dear Sir, to judge this case. It is a protective measure to patent this theory before it is published. I do not believe that the fact that I was the father of this idea will be disputed.

I have got to stop, because I am tired. The thermometer reads 42 centigrades, which is too hot to think clearly.

The high-speed railroad gives me much to think about. I shall write you in the near future on this subject. Besides I have to give a reply to several questions you asked me.

With an amiable handshake, I am

Your devoted Mbuillard.

I am not going to send my book in this mail, because I have to read it over again and make some corrections. It will follow a little later.

August 18, 1891

Letter from Mbuillard to Chanute.
MISSING

September 5, 1891

My dear Mr. Mouillard,

I went to the country, and hardly had I translated a quarter of the first part of your book when I received word to come to New York in reference to an important job.

I spent there almost the entire month of August and on my return I found your three letters of July 11th, 16th and 21st. Today I received yours of August 18th, also the second part of your book.

I have to go back to New York tomorrow and so will not have time to write you a long letter; but I shall do so soon.

Probably you have heard of Ader's experiments near Paris, but I am mailing you all I was able to procure pertaining to them, just the same. It seems to me that he tried gliding flight and that he had difficulties to overcome. I should like to have your opinion about it.

I am just finishing an article for a periodical in which I speak of you.

I am carrying your ship and your lubricator with me, in order to show them to the experts in such matters.

Your most devoted,
O. Chanute

Cairo
September 22, 1891

My dear Sir,

I just received your letter and hasten to answer it. Thousand thanks for having taken my ship and its attachments along with you to New York. My most ardent wishes of success are with you. I shall have so much need of a little comfort in order to demonstrate to all concerned the truth of the contents of my two books.

From Mr. Langley I received his study on the resistance of the air. At the same time the mail brought me the August issue of L'Aeronaute whose first article contains a variety of disparaging remarks about this book, a fact which was far from pleasing me. What was the idea of Hureau de Villeneuve? In my letter of acknowledgement and thanks to Mr. Langley I could not resist to point out to him that not all Frenchmen share the opinion of the Société de Navigation Aérienne; - this was only fair. When you get back to Chicago, please read this article, it certainly will displease you.

To these people I do not exist. As far as I personally am concerned, this is a trifle, but as to soaring flight, that changes matters entirely. Soaring flight is an actual fact, and unless one is entirely stupid and absolutely blind one must admit it. But don't you see, it comes from Egypt and not from that small club in Rue d'Amsterdam!

I am discussing aviation with you, yet I do not like to converse about it, because it seems to me perhaps unjustly so that your letter expresses a kind of fear that my book might arrive after the solution of the execution of this problem.

Let us consider the matter. First of all the person at the window of the machine shown in "L'Illustration" is not Ader at all, but me. This accidental resemblance created much fun in Cairo. Furthermore, more seriously, what kind of a machine is it, which in its outlines resembles very much theoricure vulture on page 1 of "L'Empire de l'Air"? Is it a flapping wing machine? One may guess so by noting the two rods which stick out in front and in the rear of the opening. What kind of a propeller made of feathers is this, a thing impossible in mechanics? Where is the machine which it actuates? This drawing is a fantasmagoria nothing else. The same may be said of the article in the Figaro. Whom is he going to make believe that the gyps fulvus come down at the call of these Arab women; this cry (u - u) is a cry of joy during the festival. Men never use it, because to do so one must be a high soprano. There is in all Algeria no bird with a wing span of 2.75 meters, and he has seen one of three meters at the first glance. This is pure humbug. If you want the true facts, depend on my book, it contains no falsehood; if a measurement is given, it is very accurate and very correct. When he saw my bird studies, drawings and calculations in support of this claim, Drzewiecki was nonplussed. He admitted his surprise, to be confronted by documents whose voracity may be trusted explicitly.

Furthermore, had he (Ader) hit upon a perfect engine and propeller, the least he could have done was to adapt them to a dirigible airplane. Through "l'Empire de l'Air" he knows about vertical control, but horizontal control is in your possession only. And unless you suppose that he has caught the first sight of a large vulture, he is just taking a stab at it. I have spent more than ten years trying to understand this control; wouldn't it be surprising if he understood its form at first sight? As to discovering this control elsewhere, I admit that I do not know where it may be encountered. At any rate, not in the files of "L'Aeronaute." The same is true of Trouve's little plug socket. This is a particular application of Bourdon's air pressure gage, but from there to the theory of soaring flight created by God and recorded by your servant long ago is quite a step. After "Vol sans Battement" is published, airplanes could be built, but with "L'Empire de l'Air" alone, such a task would not be easy, especially at the first attempt.

It seems to me, with no false pride, that you may continue with the translation. I have the advantage of the life of an observer.

With a hearty handshake, I am always your most devoted

Mbuillard

I have read once more the article below the drawing. It is very well founded. I am entirely of the same opinion as the writer who signs himself with the initials G. M.

October 28, 1891

Mr. L. P. Mbuillard

Dear Sir,

I received your letter of September 22 just as I was about to give you a report of the results of my transactions in New York.

I believe that it will not be too long before your boat and your rotation indicator may be disposed of profitably. However, it takes time to find a man with money who would be willing to defray the expenses necessary for the preliminary tests. Fortunately very much attention is paid at present in America to the shape of ships. On the Great Lakes a new whale-back type ship is being built, and on the Hudson river two yachts of a different type have been built, the "Norwood" and the "Vamoose" which have extraordinary speeds. Therefore, as the idea for something new has taken hold, I believe that we shall find somebody to try out your model. I am sending you all the information I could get on this subject.

I think it would be better to start with your "lubricator" when there is a possibility of getting a patent for it. For this purpose I have been in Washington to get some information on really competent patent attorneys (for there are many inefficient ones) and I have taken up the matter with Mr. Whittlesey who, to me, seems to be just the man we need. According to the American law, only the inventor has the right to take out a patent and his signature is needed for this purpose. In case the preliminary examinations show that the idea is patentable, I suggest having the necessary papers made out in your name and to send them to you for your signature. The laws of other maritime countries are such that the best manner of procedure would be to retain the American patent at the patent office (one has the right to do so for six months) so that it is not made public before the patent claims are applied for in Europe.

I asked a friend of mine who has a small steam yacht to make preliminary tests on greasing the hull with crude oil. I shall inform you of the results.

Within a few days I shall write you again to take up the other subjects of your letter.

Yours as ever,
O. Chanute.

November 16, 1891

Mr. L. P. Mbuillard

Dear Sir,

On the subject of your "lubricator" Mr. Whittlesey writes me as follows: "I believe that the enclosed patent No. 429,125 anticipates Mr. Mbuillard's invention. It is true that in this patent the distribution pipe is not fixed permanently on the ship, but considering that Gregory's patent No. 303,999 shows a pipe running along the ship's outline to distribute oil for calming the waves, it seems to me that the patent office will decide that attaching a pipe permanently to accomplish the purpose is not a new invention, as shown in Freeborn's patent No. 429,125." I am sending you these two patents.

Mr. Whittlesey's reasoning does not seem correct to me, so I wrote him again to reconsider the matter.

One can always get a patent by making such a trifling claim that the patent office cannot refuse it. This is what you ordinarily get by employing cheap lawyers, because they sacrifice the interest of their clients in order to collect the fees. But if I can get you a patent, it must be good and valid in order to prevent infringement.

Have these patents translated and give me your opinion.

Consider also different ways to obtain the same result; for if experiments show that the cost of the crude oil used is less than that of the burned coal, the idea should have some value.

Yours as ever,
O. Chanute

November 16, 1891

Mr. L. P. Mouillard

Dear Sir,

Professor Langley asks me if it would give pleasure if a naturalist of the Smithsonian Institute would write an article on the flight of the birds, giving quotations from the *Empire de l'Air* and the "*Vol sans Battement*." This publication would only be scientific and you wouldn't get anything out of it but renown.

Considering your book like a "fidei commis" I cannot show it without your permission, but I don't see any disadvantage in showing the purely descriptive parts. Even for the other parts, I have such faith in Mr. Langley that I should be happy to be able to communicate to him all your ideas so that together we could try to find out what profit can come of it.

There are some among them that could be offered to the Government, for instance, the large boat, and Mr. Langley has such a high place in Washington that his help would be invaluable.

I am afraid you think that I don't act quickly enough in your interest, and I wish to hasten the realization of your hopes.

Your
O. Chanute

November 27, 1891

Letter from L. P. Mouillard to O. Chanute
MISSING

December 10, 1891

Letter from L. P. Mouillard to O. Chanute
MISSING

*See pg 58
in book at
volume*

December 15, 1891

Letter from L. P. Mouillard to O. Chanute
MISSING

January 4, 1892

Mr. L. P. Mbuillard

Dear Sir,

A few days ago I received your kind letter of November 27 and I am glad to learn that your health is improving.

I returned from New York where I spent some time in the interest of the society of civil engineers. I saw my friend who owns a yacht, but owing to lack of time he could only make rather unimportant experiments with the "lubricator". However, he noticed that the thin streams of crude oil have a tendency to rise directly to the surface instead of being distributed along the hull. Consequently the effect is trifling. He thinks that the distribution pipes should be placed all along the ship and that it would be better to make an emulsion of the water and the oil in order to separate the globules before discharging them against the hull. As soon as spring is here he is ready to try this latter method. He does not believe that air would be efficient, as it is much lighter than water and therefore would rise to the surface at once instead of passing to the rear (of the ship). One could also put a pipe under the keel, all along the ship, to distribute the air or the oil. But how could this be arranged on ships which are already launched and how, in case of need, could such an arrangement be inspected or repaired?

However, I believe that all this can be solved. It is necessary to work out the results of experiments, which almost always interfere between an original idea and its realization. In order to expedite matters I intend to let another friend of mine in on your idea so he, or his part may also make experiments. As this increases somewhat the chances of appropriation by somebody else, I am thinking of placing a "caveat" in your name with the patent office. This is a kind of date fixing which prevents other inventors from patenting a similar invention within one year, if one is not quite ready to take out a patent oneself. The only thing I am afraid of is that you may think that I am not working fast enough. For a start I selected the "lubricator" as it is the simplest of your ideas. However, I am ready any time to switch to something else, if you so desire.

Yours as ever
O. Chanute

January 17, 1892

Mr. L. P. Mbuillard

Dear Sir,

I received your kind letter of December 10th, also that of the 15th concerning the high-speed railway.

I am leaving this evening for Washington to come to terms with Mr. Whittlesey (patent lawyer) in regard to your "lubricator", and also to hand your book over to Mr. Langley personally.

At the same time, I plan to see some officers of the U. S. Navy in reference to your ship design and also the engineers who are about to make experiments with a high-speed train model near Washington. This is the model I told you about some time ago. However, I must tell you that after having read your letter of the 15th and reread the chapter on "penetration" I am wondering whether your conveyor would not have more speed if the butt-end was in front. This is indicated by the form of the bluntest part of birds and fishes, and those which you recommend as models deal with ice almost as much as with water. Moreover, the theory that the streamlines when they come together again cannot create a propelling force when the stern is longer than the stem, seemed always correct to me. I therefore am taking the liberty to make some reservations when showing your designs, and leave it up to the experiment (if I can have one made) to decide whether the machine should travel with the blunt end in front or in the rear.

In one of your letters you asked me to get you some information in reference to experiments with look-out balloons. I am sending you everything I could get, also other newspaper clippings which might be of interest to you, including an article by Mr. Maxim.

Unfortunately most of this matter is in English, but I hope you may be able to manage it.

I have about half of your book translated and I shall mail it to you as soon as Mr. Langley has read it. I have to work somewhat by fits and starts because I have to attend to so many things.

I started with the designs for an airplane as a first attempt, according to your method. But the breaking strength of the materials is a terrible stumbling block. You would greatly oblige me if you would give me fuller instructions if you want me to make experiments.

Yours as ever
O. Chanute

January 27, 1892

Mr. L. P. Mouillard

Dear Sir,

I returned from Washington where I handed over your book and most of your letters to Mr. Langley personally.

Before accepting the book he asked me whether it contained some ideas on aviation which are patentable. When I answered him in the affirmative, he asked me to keep the chapters in which these ideas appear, because, said he, one never knows how an idea creeps into one's mind. He does not want to unwittingly expose himself to appropriating something that belongs to you.

I first insisted that he take the complete book but then according to his wishes I retained the chapters "Trial Airplane", "Horizontal Control", and "Vertical Control Surface", also several letters which give some details on these subjects.

Your book will be kept in a safe, and I put each chapter in a separate envelope so that the pages, which I first numbered with a pencil, do not get lost.

My first idea was to build a trial airplane before applying for a patent for you, because one never knows exactly, as long as the idea has not been put into practice at all, what and how many points the patent should cover. But due to an incident in reference to the "lubricator" which I shall explain later, I began to change my mind.

Therefore, I believe that it would be much better to apply for a patent for the glider in your name at once and to supplement this patent later on by others if necessary.

In case this procedure meets with your approval I kindly ask you to send me everything necessary to have the papers prepared for your signature. Also advise in what countries you deem it of advantage to patent your glider, so that I can take the matter up with Mr. Whittlesey on the proceedings, to apply for patents simultaneously in the various countries.

To tell you the truth, I, for my part, would prefer that you apply for a patent for your invention in France first, and that you send me your drawings and documents when your interests are covered by the proceedings in France. It is true that you would lose two years on the American patent which is 17 years instead of 15, but which expires at the same time as the foreign patent if the latter antedates the American patent. However you would be sure in this case that the patent is valid as you intend it to be, furthermore that I have not appropriated anything from you if I should decide later on to apply for a patent myself for the ideas as I told you about and for others which may arise.

In case you decide to start with the French patent, let me know how much money to send you to defray its costs and those of the copies you are going to send me. Under separate cover I am mailing you some information in English pertaining to American laws relating to patents.

As to the incident concerning the "lubricator", I chanced to read in the London technical magazine "Engineering" of January 1st a letter of General Hutchinson who proposes approximately the same idea as you. I have translated this letter in its entirety and herewith enclose it. Moreover several months ago Mr. Langley was struck by the same idea, while studying the porpoise which is a sea fish which exudes oil over its entire surface, but Mr. Langley does not intend to take out a patent.

After a consultation with Mr. Whittlesey, I believe, that instead of applying for a "caveat" for you, it would be much better to apply at once for a patent which should contain all the variations you can think of, so nobody can apply the idea whatsoever merely in a somewhat different way to dodge the patent. The papers are being prepared and I expect to get them within a week when I shall mail them to you to sign them as soon as they get there.

Fortunately it may be seen that General Hutchinson's idea is still rather imperfect.

It is also fortunate that I correspond with him and have rendered him a small service by advising him of a method relative to his invention to keep a balloon always inflated. Therefore, I wrote him that I am experimenting with the same idea (lubricator) and asked him whether he intends to apply for a patent. The only thing that worries me is: what is absolutely the best way to avoid any waste of crude oil in order to produce results with the least quantity possible.

With a handshake I am

O. Chanute

Translation of an article published in
"Engineering" of London, January 1, 1892, p. 20

THE EFFECT OF OIL ON THE SKIN FRICTION OF VESSELS

To the Editor of Engineering

Sir, - The security obtained by ships in stormy weather from a thin film of oil smoothing the surface of an agitated sea has often been described in the public papers, but no remark seems ever to have been made respecting the increase to speed that would be gained were such a film spread over the submerged surface of a vessel. The increase would be so great that surely some thought should be given to the subject before it is dismissed as chimerical and impracticable.

The cohesion that has been manifested by the particles in the thin layer is so encouraging that it seems well worth while to consider whether numerous minute streams of oil could not be ejected in direct contact with the submerged surface through holes in the aftermost side of flanged vertical pipes, much flattened to prevent opposition to progress. On the principle by which at a fire water is drawn up and expelled with power from the engine, oil, taken from supply casks, would be forced against the ship's sides with but little exercise of steam or mechanical power. As the ship progresses, the oil, meeting the water, would be pressed towards the stern, while the inward pressure of the water would prevent the oil from quitting the ship's side. Horizontal, slightly indented lines would aid the flow of the oil towards the stern. It is possible that some day ships may be built with depressed grooves for receiving the oil, in order to dispense with pipes, which more or less break the even surface of the ship's sides.

At the bow a centrally fixed vertical pipe would discharge oil from both sides.

The lateral pressure of the water and the cohesiveness of the particles of oil would resist its rising to the surface while the ship was under sail or steam. In harbours which have tides on a ship's swinging her anchor, the oil would spread over the bottom as effectually as if she were at sea. In tideless harbours the oil would be expelled from a pipe or pipes attached lengthwise to the keel.

An oil would be selected of the quality and consistency best calculated to meet the desired purpose, and it would be so treated chemically as to prove inimical to the growth of weeds and barnacles.

Chemistry is constantly making such marvellous strides in useful discoveries that it may be possible ere long to obtain a mixture for which oil would have a greater affinity than water. Such a mixture rubbed over a ship's bottom before she left her dry dock would render success certain.

Surely by ingenuity and an exercise of the inventive talent possessed by many of our engineers, experiments could be made at a trifling cost that would show whether there was a reasonable prospect of their labour being superabundantly rewarded were energetic steps adopted - a success that by diminishing the length of voyages would diminish expenses and risk at sea in peace as well as war, thereby greatly aiding commerce.

Would not some light be thrown on this important subject were a duly bent, vertical board, running upon wheels, to travel round and round in an annular trough filled with water? Attached to the exterior side of the board would be several vertical, perforated pipes, as described, fed with oil (from a cask at a considerable height) flowing through a vertical central tube, terminating in horizontal radial tubes, one to each pipe. The radial arrangement would be united to the stationary central tube by a socket joint open in its centre. By an arrangement acting below the joint on a central fixture, the board could be driven in a circle at any required rate, but never so rapidly that the spreading of the oil could be affected by centrifugal force.

Could the proposed coat of oil be given to the submerged surface of any ship, it would be difficult to determine what might not be her gain in speed, for the repugnance, as we may call it, of oil to adherence with water shows that practically there would be no skin friction.

Your obedient servant,

W. N. Hutchinson, General.

December 28, 1891

January 31, 1892

Mr. L. P. Mouillard

Dear Sir,

Enclosed you will find:

- 1.) Application, description and oath required by American law to take out an American patent for the "lubricator".
- 2.) Blueprint of the drawing attached thereto. (A drawing has been stupidly copied on the wrong side, but it is not worthwhile to lose time waiting for another copy.) Point out to me all variations which you have thought of and we will put them in.
- 3.) Mr. Whittlesey's letter in English.
- 4.) A translation of this letter. I made a cross-mark on the empty spaces to be filled in as explained in this letter.

As you will have to complete the papers before an official of the United States who necessarily speaks English and so can explain them to you, I did not translate them, besides I am very busy. However, I kindly ask you to have him explain well to you the description (specification) made of your invention and to mail me any improvements and amplifications you have in mind. We may take out or add typewritten pages between the official printed ones. It is my desire that your patent should be as complete and of as wide a scope as possible.

With a handshake,

O. Chanute

February 3, 1892

Mr. O. Chanute
Engineer
Chicago

My dear Mr. Chanute,

I herewith confirm my letter in regard to high-speed railroads. This is in reply to your kind letter of January 4th.

The experiments which your friend made on his yacht are quite contrary to what has been devised and to what is going to take place in practice.

He says "that the oil streams have a tendency to rise directly to the surface instead of being distributed over the hull and that consequently the effect was negligible".

First of all it is only possible to produce continuous oil streams when the ship is at absolute rest. As soon as the ship makes any forward motion the oil stream is intersected. The sections will be the shorter and more numerous, the higher the speed, so that, when the speed reaches 20 knots, each section chopped off the oil stream will be certainly not even as big as the head of a pin. The rising of these droplets to the surface is not as easy to apprehend as it may seem at first sight. The speed with which they come to the surface depends 1.) on the density of the oil, 2.) on the size of the droplets, 3.) on the depth from where they are ejected. If the density of the oil is good, the point where the droplet arrives on the surface will be the farther from the perpendicular, the faster the ship travels. This is an indisputable fact. It even may be possible that the oil greases the screw and the rudder or even goes to waste without having touched the ship at all. This will happen if the droplets are too small while the speed of the ship is very high. Such a case should be avoided as it means a dead loss of material. To remedy matters it is only necessary to increase the size of the droplets.

However, there are certain difficulties in connection with the production of properly sized droplets. The density of the oil is hard to change. Addition of mineral salts to increase its density is not practical and besides, expensive, so this method is out of consideration. The wisest thing to do is to select the most adaptable oil. I have already mentioned crude oil just as it comes from the well. It needs no other preparation but filtering which takes out the dirt. As there is no means of changing the density, other measures must be considered. The first idea would seem to discharge the oil in the lubricator at a speed which would cut the oil stream into properly sized drops. However, this method is not applicable, because it requires an unchanged speed of the ship; once under way it must proceed at a uniform speed. Considering the size of the holes from which the oil is ejected into the sea, this size is invariable, at least for the duration of the trip. To increase or decrease these holes is a delicate operation which could only be done in drydock. So this method is out of consideration.

There remains only one way: a regulating device of the force needed to eject the oil. Such a regulator will be always under control; one has always the choice between ejecting one liter or several liters at any one time, or if a pressure injector is used between, ejecting plenty of oil under strong pressure or a little at a time, and let it flow out almost by itself. These are the guiding principles, and it will be up to the man in charge to estimate the course to use by an attentive study of the log and of the wake of the ship. The wake will be more or less brilliant due to droplets that did not attach themselves to the hull.

As a good rule I estimate that the oil should almost be completely deposited on the front half of the ship. The rear half will be greased by the forward motion of the ship; the oil will be dragged along and pushed to the extreme rear by the friction of the water on the ship.

So you see that the lubrication, notwithstanding its great simplicity, requires much consideration in order to be employed efficiently.

The advantages and disadvantages of this lubricator will be discussed by those interested in sea transportation, as soon as they learn about it when the patent is taken out. You probably will be questioned about it very often.

The best explanation can be given by experimentation which will determine the value of this method.

For a simple experimentation it is necessary to adapt the lubricator to ships in actual service. This could be done in the following manner: T is the extreme point of the fore part of the ship's prow. L is the lubricator consisting of a triangular copper pipe which is perforated at a and a' to release the oil on both sides of the ship. This triangular pipe is well riveted to the prow at R, R' R² and R³ and cannot be torn away by the waves because it forms a solid unit with the ship's structure; besides, it is constantly supported by the forward motion of the ship. The construction and installation of this device are so simple that it is unnecessary to waste any more words about it.

As to the length of the pipe, it should be as long as the entire prow and should pass below the structure and cover at least one third of the depth of the keel. In any case one half of the length of the keel would be amply sufficient because owing to the pitching of the ship the waves will pass the extreme rear at the point where the oil is ejected and is about to rise to the surface. This certainly should be sufficient to grease the rear of the hull and even the rudder.

This experimental arrangement is necessarily extremely fragile. While in port, the first chain which comes in contact with the fore part of the ship, or the first small craft which turns around it and bumps against it are apt to damage the lubricator. It therefore should be protected without fear of any damage. While this trial arrangement may not be perfect it makes possible to experiment at very small expense.

Now, dear sir, permit me to ask you for some information. I am very anxious to know what you have decided to do about my book and what you intend to do with my ship and its accessories. Furthermore you would greatly oblige me by telling me how you think to present my lubricator in the newspapers and before the public, the same lubricator with which you wanted to get things going. I admit, I have not formed an opinion about it. I presume that a start has been made and I have the greatest faith that it will work well; only it seems to me that it should be presented in such a way that it may be discussed and tried out, but not to risk it to be appropriated and so to interfere with taking out a patent. It seems to me that once you have the patent you will be in an exceptional position to offer it for sale.

If at the same time, you would be kind enough to inform me in a few words what you decide to do about the Alpine balloon and the airplane you would greatly oblige me. I kindly ask you to excuse my curiosity and to blame it on the distance which separates us.

Please accept my most cordial greetings.

With an affectionate handshake, I am

Mouillard

February 11, 1892

Mr. L. P. Mouillard

Dear Sir,

On January 17th, I wrote you in reference to your book, on the 27th in regard to your lubricator, and on the 31st I mailed you the patent for your signature. I hope you received everything.

I asked Mr. Whittlesey to send you all American patents which resemble your glider, according to the enclosed list. You must have seen Du Temple's, d'Esterno's, and Ader's patents which come close to yours. In order to take out a valid patent it will be necessary to single out what is new and useful on your machine in comparison with what has already been patented by others. If you should decide to take out a patent in France first, I believe Mr. Dieuaide - 62 Rue de Provence - knows this line of business better than anybody else.

I am going to leave on a trip to the South and then to California. I may be away for two months, but my mail will be forwarded to me so that there will not be much delay. I have three chapters of your book and Mr. Langley has the rest. Should anything happen to me, I have made such arrangements as to have all this material returned to you.

I think your book should be published as soon as your inventions are covered by patents.

They are, as I recall:

- 1) Airplane
- 2) Dirigible parachute
- 3) Balloon valve
- 4) Alpine balloon

To tell the truth, I do not believe there is much money to be made with the dirigible parachute nor with the Alpine balloon, and I am not able to pass judgment on your balloon valve. I have read carefully the chapter on kites and found nothing in it to be patented. The chapter is too short and would be more interesting if you would discuss kites in twice the words.

The shape of the ship lubricator, the rotation indicator, the rational propeller, the observation post for the Navy, the dirigible balloon without engine, the Navy torpedoes, the ore separator, and the dew collector are not mentioned in the book, so you are the sole owner of them.

In my opinion your principal invention is the airplane and I would even suggest that you disregard all the others so that you may be able to give your entire attention to the development of the glider. The conception of a basic idea as a unit is one thing, but its realization by combining all the elements capable of resulting in final success is quite another thing.

With a handshake I am

O. Chanute

Cairo
February 23, 1892

My dear sir,

I herewith return the application signed by the U. S. consul in Cairo. I hope everything is alright.

There is another matter which I hope you will do me the favor to accept namely to place this patent under your patronage. You told me that "good deeds make good friends," so please permit me, dear sir, to return this citation and to tell you. If the subject treated in this patent, if the idea therein expressed does not seem to you to be too insignificant you would give me a real great pleasure if you would make the ownership of this patent read: O. Chanute and Mouillard.

As to the patent of the airplane which you suggest to be applied for in order to demonstrate gliding as explained in my books, I wish to tell you that I am too far removed from the civilized world. Actually the United States are far in the lead in this movement, while, alas! Cairo is so far away; for this kind of idea it is an absolute desert. You would greatly oblige me if you would take this matter into your own hands as I do not know how to proceed. And always, if you please, under the condition that any patent taken out in this way should be issued to O. Chanute and Mouillard.

Last December I mailed you a letter in regard to the shape to be given to a high-speed train. Please advise whether you received it, and what you think of it.

With sorrow and regret I read Mr. Langley's decision not to accept those chapters of my book which contain patentable ideas. I do not know whether the value of what is expressed in these chapters is over-estimated, but it seems to me, that he would have found certain interesting points. When the time comes that you have the patent, I hope that he will have no more objections to acquaint himself with the rest of my book. He then will have an explanation of the machine which I hope will interest him.

When you write Mr. Langley please convey to him my most sincere thanks for the interest he has shown toward me.

And you, dear sir, I really do not know how to appreciate your great kindness toward me. With the feeling of deepest affection and appreciation I shake hands with you.

Mouillard

Cairo
February 25, 1892

O. Chanute

Dear Sir,

Perusing the description of the patent, I noticed some new addition that I believe should be credited to you, dear sir; it is a point where there is a matter of mixing water and oil. I had thought of this mixture but had hesitated to mention it. Since it is mentioned in this paper, allow me to elaborate on it.

Oil can be mixed with water only if it undergoes a chemical change that can be obtained by mixing it with soap. In this case an oil emulsion results that makes it soluble. This is one of many possible transformations of this liquid which I have mentioned several months ago, when I mentioned among other things to dissolve euphorbial resin which has the property to prevent rust on iron. Therefore, this point should also appear in the patent.

When the description was read to me I noticed a passage which mentions the air blower. This blower, or in other words blowing compressed air before or after the introduction of the quantity of oil, has the purpose to specify the point of the pipes where the oil is supposed to be ejected.

If the oil is to go to the bottom of the pipes, that is to the deepest point, air is blown into the pipes to drive the water out of them and thus to make them empty. After this procedure oil is let into the tubes and flows to their deepest point, as there is no more water to obstruct this flow.

If, on the contrary, the surface (of those tubes) is to be greased, the water is not driven out of the pipes by compressed air. The column of oil acts by itself, as due to its height (less small difference of density) it pushes back the column of water. In this way the oil remains near the surface and is ejected at this point.

As to the blower, I have to admit that I have not formed a clear opinion on the good or bad action of the air bubble as a correct medium to decide on the gliding of the ship through the waves. A log accurate enough to indicate an increase or decrease by a fraction of a knot would be the only means to settle that question. However, there are two other useful actions of the air bubble which I think should be explained.

The first would be that it presses the oil droplet against the side of the ship and fixes it there by means of plain mechanical compression, because its ascending force is very great. (The difference of the density of air and water is 1.3:1000.) So the air bubble is in this case a mechanical medium, a compressor.

The second action should have been made clear to you when I answered your questions on the effect of billows on the large flat surface of my ship. I admit I did what one often does, I answered beside the question. When a large mass of air is blown by powerful ventilators to the extreme front which has been transformed into an immense prismatic pipe with thousands of holes, the effect looked for of the large blower is to use the air bubble as an elastic cushion to absorb the violence of the shocks of the waves in order to reduce the breaking action of the billows. As a matter of fact, on ships without a blower the shock of the water (an incompressible fluid) on the steel plates forces these plates to bend constantly because the bearing action of the ship is slow; the water does not give way at once and the ship does not give way either by rising which takes place only a few instants later, so the plates form an elastic cushion and withstand the shock.

However, when there is a large quantity of big air bubbles, a gas which is extremely elastic, between the sides of the ship and the waves, the pressure of the shock acts first on these air bubbles and decreases their volume, in this way the plates will be a great deal relieved; between them and the turbulent water will be a cushion of an absolute elasticity which protects the plates from the dangerous shocks which stagger the ship, loosen the rivets, and most of all stop the motion of the ship.

In my last letter I showed you how I thought this device should be constructed. By necessity this is a simple and imperfect way because it is to be adapted on ships in actual service. Here is the way the device should in my opinion be installed on large liners to be built.

(P. 71)

The drawing represents the nose of the ship. A is an inlet tube for compressed air under a pressure of about 1.5 atm. If cock 1 is opened, the air is forced into the lubricator L, L^1 , L^2 . If cock 1 is closed and cock 2 is opened, compressed air is forced into the oil tank keeping the oil under pressure. Cock 3 controls a tube which draws oil from the tank and feeds it into the lubricator. D and D^1 are pressure gages. In order to let the oil flow out on the surface, cock 2 is opened. The oil is put under a pressure which is recorded by gage D^1 , then cock 3 is opened and the oil is forced into a pipe which is the lubricator.

If the oil shall be sent to the lowest part of the lubricator under the ship, at L^1 , L^2 for example, cock 1 is opened causing the air to push out the water column which flows out through the holes and through the lower end of L^2 which is open. When the lubricator is empty, cock 1 is closed and cock 2 is opened, then after a few moments cock 3 is opened also. Here is what takes place: If the three cocks were opened at the same time the pressure would be uniform, but if cock 1 is closed the pressure of 1.5 atm. is expected to drop. It decreases because a part of the air escapes through the holes of the lubricator, therefore the pressure becomes less than 1.5 atm. The oil itself is under a pressure of exactly 1.5 atmospheres. The oil will flow with a force in proportion to the time that elapsed between the two operations. The difference between the two pressures may be easily verified by watching the gages. D^1 will indicate 1.5 atm while D indicates the decreasing pressure.

Note. The oil tank should have many perforated partitions to counteract the motion of the oil.

Note. The inflammable liquid which is considered hazardous is completely isolated in the fore part in an entirely enclosed place. A single man controls the operation by opening and closing three cocks. When the device is properly taken care of, spilling of oil should be almost nil. Therefore, there is no cause to argue about fire hazard.

Cairo
March 7, 1892

Mr. O. Chanute, Engineer
Chicago

My dear sir,

On February 26, I returned to you by registered mail the patent, stamped and signed by the U. S. consul general in Cairo.

On March 3rd I received from Mr. Whittlesey 5 copies of patents granted in the U.S.A. on the problem of aviation. I shall study them as soon as I see my translator and shall report to you on them in my next letter. This letter will also take up the subject of the airplane to be patented, according to the wish expressed in your letter of February 11, which I just received.

This letter contains a study of variable pitch propellers.

You may have noticed in l'Aeronaute of July 1891, pages 165 and 166, also in its issue of January 1892, page 18, that this type of propellers creates great interest. It remains to be seen whether they are in actual use and whether they have been patented. In any case, as I do not copy from anybody, it is probable that mine may differ in many points from those which are proposed; some indications to that effect can be found on pages 165 - 166 of L'Aeronaut. The ideas are based on the same consideration. But as I do not know them, as I do not care what somebody else is doing, I do not appropriate anything of anybody. As the objectives to be attained are different it is very probable that the propellers must differ from one another.

Mr. Hureau de Villeneuve should have this information, because he knew Croci, Spinelli, and others who devoted themselves to this type of propellers.

These propellers are certainly not identical and I suppose that the two pressure regulators - one for rivers and one for the sea - are entirely new, as well as the log that makes it possible to balance their action; they have nothing to do with this case. Therefore the question is to compare the production and to patent new ideas if there are any.

I think I should have brought them out twenty years ago, but could not. Notwithstanding this delay, I think you will judge it advisable to study the problem, because the propeller is such a big proposition. At any rate there should be a possibility of taking out a patent for variations or improvements; the law cannot stop the complete study of such an important question by means of a patent.

This is for the experts to decide.

This letter may arrive a few days before your return from your extensive tour to the South and California. I hope that this trip has been a happy one for you and that it has not tired you out too much.

From the standpoint of observing birds, you may have encountered, it is too bad that your voyage took place in February and March. This is a poor time for studying the large soaring birds because they are busy with their nests and do not congregate. You therefore, may have seen solitary birds only.

I hope you have seen in the South the small aura and urubu vultures that may be found around towns. These are birds with grey and black plumage, but their flight has nothing remarkable to offer. Then perhaps a bird with brilliant yellow and violet colors and a gaudily red head and caruncle like a big turkey, its soaring flight should be of some interest (*Sarcorhamphus papa*). But above all, when crossing the Rocky Mountains you may come across the large vultures, the condor and the catharista. These two birds are able to execute soaring flight in a most conclusive manner. Their flight is a spectacle to be wished for by everyone who likes aviation, and is a demonstrative lesson which supports my theory.

I hope you had good eyesight so you could observe with attention the scenery and the flight of the birds, so that you may tell me all the motions they went through.

As I know theoretically the birds of North America as well as those of the Old World, I might perhaps be able to tell you what kind you have seen.

I wish to thank you very much for what you had to say about my book in the February 1892 issue of the Railroad and Engineering Journal; I also thank you for the other numbers you were kind enough to send me; they are of great interest to me.

With an affectionate handshake I am

Your devoted
Mouillard

April 19, 1892

Letter from L. P. Mouillard to O. Chanute
MISSING

May 20, 1892

Mr. L. P. Mouillard
Dear Sir,

On my return from California I received your letter of April 19, with the drawings of your airplane.

Up to now I am busy preparing the drawings and the description in English so that Mr. Whittlesey can make application for the patent. I may have to ask you some questions, so as to make absolutely certain that all your ideas are covered.

For instance: Do you expect that this machine will create suction and move against the wind with flat surfaces on the bottom side, without losing altitude? I doubt it. In your report you state: "Then the wing tips are turned forward, the load moves toward the rear and the airplane rises." I understand that but does it move forward at the same time? Does it not rather drift, a motion which birds are forced to make only at high wind. Please give me more particulars about the motions which you believe are possible with this airplane.

When you have a chance, study D'Esterno's patent. In his balance English patent he cites three principles to be observed; equilibrium, control and impulse. He gets the first by changing the position of the center of gravity, the second by changing the position of the wings and of the center of gravity, and third by flapping the wings. He says wind is necessary for gliding flight.

Examine also Du Temple's patent. He says that the equilibrium is produced by the motion of the wings in relation to the center of gravity. Control of vertical direction is obtained by means of the tail and horizontal control by the motion of wings and tail.

It is very probable that these two patents are being held against us and I want to be prepared to defend our interests.

I thought I could tell you in this letter about what I saw in California. However, I have to postpone it, as I had to attend to various other matters on my return. But I believe that this will be the topic of my next letter which will be a rather long one.

Kindly let me know how much deposit money would be necessary to publish your book in France. In America I found a publisher who wants to print an English edition at his own expense and to pay you 10 percent of the gross receipts.

With a handshake I am,

O. Chanute

Note the change of address: 413 Huron St.

Cairo
June 14, 1892

Mr. O. Chanute, Engineer
Chicago

Dear Sir,

I hasten to answer your questions submitted to me in your kind letter of May 20.

Question: "Do you think this machine is able to create suction?"

Answer: Certainly yes! and a thousand times yes! and lift also, or two and two do not equal four! The master does it and its pupil, man, will do it, and by the identical means. One may object that the master is the bird which is created with an inherent knowledge of flight, with muscles of incomparable power, and with a perfect structure to carry out this locomotion. My reply is: Among the various maneuvers the bird is able to perform, humanity is interested in one: Flying from place to place. As this kind of flight is made in a number of manners by the various families of birds, we make a selection among them and take as a model the one whose maneuvers may be imitated. This is the family of the large vultures. Continuing our selection in regard to the flight of this family we eliminate any action which is not quite absolutely an action of translation, and we arrive at "flight without flapping wings" which is expounded in my two books on aviation. The disadvantage of the human airplane will be the difficulty to make it large and strong. However, it will have as advantages the slowness during maneuvers and a gliding capacity without equal due to the greater importance of its mass. Therefore one may admit that there is equality.

More and more I get a clear idea of the road I have laid out but also of the difficulty to transmit it to the human intelligence. What may be the reason that I alone should understand? I believe it is due to two causes: First, that I have been placed into a better position to observe than most of the investigators; then, perhaps, due to a particular individual characteristic, namely a great love for the sport of gliding. There are people who love horses, others who like boats, and others again who like bicycles, but I confess of having always been impressed by gliding. My first teachers were a plain family of kestrels. All their activities whereby they employed flapping wings left me absolutely indifferent. But when they started to glide, my attention was aroused, causing me at once to think of a medium to reproduce this maneuver which only requires intelligence, dexterity, and so to speak no waste of power. Later the stork, due to the greater extent of its motions, helped to disentangle a large number of points which the small size of the kestrels prevented me from analyzing; then finally I met the master, the large vulture, a bird in whose flight there is very little to eliminate. This bird, not I, is the real author of my two books. I am only a plain copyist, a poor photographer. This bird is much more explicit and more affirmative than I have ever been, despite my style as a prophet. This bird alone demonstrates, all I can do is to say: I have seen.

To top it all, it is unfortunate that it is so hard to make others see these convincing flight motions of which I am speaking. Bregewischt and Basin have seen nothing, so to speak, while Biot refers to my descriptions. At last, you dear sir, reading between the lines of your letters, it seems to me that your report of your trip is filled with an emphasized doubt. I understand that all you ask yourself, at times, whether L. P. Mouillard is a fanatic, whether he observes well, and whether he analyzes soundly what he has seen.

The trouble with my work is that it affects any idea which is not expressed at the proper time. My two books are twenty years ahead of their time and that is their original sin.

The evolution of flight without flapping wings will be admitted only under one condition, i.e., when others, whose attention will have been aroused by my preachings, will see for themselves and then tell the aviators. This flight motion as it has been described is a reality; he has observed well and here is the proper road to follow.

Or else, a precise demonstration with experiments by means of an airplane.

Without being too commonplace we may very well consider the fact that twenty years is too long to wait and that it would be much better for us to hasten the movement a bit to increase its progression. I, for my part, believe that it takes less time to show by practical demonstration than to wait until the world has understood. If possible, let us therefore, experiment, let us try to demonstrate repeatedly, at first simple gliding flight (not once as I have done or as Ader's machine has done). As the airplane which I propose has some other qualities, these simple glides may be followed by more complicated maneuvers, ascending or climbing flight, which makes everything possible.

Now let us get back to this airplane and to the maneuvers it will be able to execute. This machine is going to live up to its properties or will fly efficiently, i.e., execute unlimited flight only when there is enough wind so that it may draw the power necessary to arise from the force of the air current. The velocity of this air current indispensable for indefinite lift and for take-off varies according to the weight of the machine, the weight of the pilot, the size of the lifting surface, the degree of perfection of the shape and the gliding quality of this surface; also finally according to the maneuvers to be executed.

It would be well to consider the surface necessary for the various flight motions. If the flight is to be slow the surface must be larger than for fast flight.

As the experiments require slowness it will be obtained by means of a surface which is loaded by less than 5 kilogrammes per square meter and which is constructed in a proportion 5 to 1; the span of the wing to be 5 and its width 1. Under these conditions, a wind velocity of 5 meters per second will be the lowest limit; below that no flight will be possible. More velocity creates a higher lifting power which when it reaches a certain limit will improve the flight of the airplane; this limit is about 20 meters per second.

Let us take an average wind of 12.50 meters and let us repeat the maneuvers which may be executed with such an airplane.

Soaring and lifting may be produced by the speed impelled. By 1.) a drop from a height of 25 meters. 2.) To give the machine by any launching method whatever a speed which together with the head wind will result in a total velocity of 15 meters per second. 3.) By means of the displacement of the center of gravity of the load under the action of a wind of less than 15 meters per second. This maneuver is carried out as follows: The nose of the airplane points into the wind and the wings are placed as far to the rear as possible. Then if the wing tips are moved forward, this simple motion causes the machine to rise and to move forward.

As soon as this machine moves in turbulent air at a speed which is able to carry it, it may produce: Suction, which means motion against the wind without falling or rising, aspiration while rising, crosswise motion to the right or to the left, flight with rear wind, and finally climbing by means of circular flight.

Therefore, it will be possible to reproduce with this machine all motions necessary for a cross-country flight, provided that all conditions enumerated above are combined: wind 12.50 meters, load 5000 grammes per square meter, and a ratio of at least 5:1.

Here is my opinion of the patents to which you called my attention: Patent d'Esterno. All I know of him is what you told me, but this simple explanation shows that his machine is entirely different than ours.

He gets "equilibrium by varying the position of the center of gravity." So do we, only the methods used to accomplish are quite different.

Control "by changing the position of the wings and of the center of gravity".

This I do not understand and on the reproduction of Dieuaide's picture I do not see how he proceeds to do so. It is one thing to control and another to be controlled. (A French pun).

Motive power by means of flapping the wings. So it is a flapping wing plane. This difference alone settles the question in a very positive way. The airplane which he patented is a flapping wing plane, while ours is the quintessence of gliding, the airplane which flies without flapping wings, and the fact that we made the wings rigid is the proof of it.

Patent Du Temple: In the chapter "Aviation" I wrote that this airplane is remarkable by its extraordinary simple construction, too simple in fact because it is not strong enough. I also say that no other control but that which may be introduced by the tail is indicated. After all, perhaps it is otherwise in the patent, Dieuaide's drawings are so much lacking in details that one does not dare to express one's opinion. If there is really nothing but the tail for control, he (Du Temple) cannot defy our two control methods. But what settles the question is the propeller in front which shows that there is no relation whatever between a pulled airplane and our machine which is actuated by the wind and by deviation.

Now I come to the last paragraph of your kind letter. First of all I must thank you for your kindness and I do it wholeheartedly. You are rendering me a very great service. "L'Empire de l'Air" cost me about 2400 francs. The success it had in the newspapers was by no means due to G. Masson the publisher, but to a chum of mine A. Daudet who opened all the doors of publicity for me. G. Masson is expensive. You have to pay for his name as a publisher. I had to make all the corrections and yet the book is full of mistakes. Especially the drawings caused me great trouble, I had to do the frontispiece all over again on a one-meter scale so the designer could grasp it, and what a horror it turned out to be in spite of it. "Le Vol sans Battement" is without illustrations, the two or three I had for it I omitted in order to save money and to have only plain printing.

I am told that in Paris the rate for printing is 60 francs for 16 pages which would mean about 1500 francs for 300 and some pages. There remains the question of proofreading. I cannot think of having the proof-sheets sent back and fro, there would never be an end to it. Perhaps Mr. Hureau de Villeneuve will have the kindness to help me out. I shall ask him about it as well as about the price the other printers charge. I shall also write to G. Masson to get his price.

As to the English publisher for the translation of this book and even for "L'Empire de l'Air" when it comes out, it seems to me that I should accept with both hands if you do not see any objection. Yet I would like to leave it up to you to decide what should be done; in this case, as always anything you are going to do will be well done.

There remains nothing else for me to do, but to thank you again, and I cannot repeat it often enough - thank you!

Your devoted,
Mouillard

Cairo
June 16, 1892

Letter from L. P. Mouillard to O. Chanute

MISSING

June 16, 1892

413 E. Huron St.
Mr. L. P. Mouillard

Dear Sir,

I started to translate the data on your airplane you mailed me and to make a tracing of your drawings. Then as I thought that your description was not large enough to avoid imitation, I made new drawings on a scale required by the patent office and a rough draft of the patent application so as to cover various interpretations, especially that of the superimposed planes. I sent the entire matter to Mr. Whittlesey asking him to put the application and the drawings in good order to as to get a valid patent, and he answered me that he comprehends the idea and its application. He says that it is very ingenious and that his draftsman is working at it. He is going to send me the documents he is preparing, for your signature.

Mr. Whittlesey asked me whether you made experiments with this machine and with what results. Kindly inform me on this subject.

I shall mail you the papers to be signed shortly.

As to your variable-pitch propeller, I am waiting for a chance to go to New York to consult with experts in the field of mechanics. Your idea is not absolutely new and perusing Bonrue's "History of Propellers," I noticed that similar positions have already been under experiment. I think that the weak point of your design lies in the manner in which you propose to adjust the rod which changes the pitch (fig. 7). It cannot come in between the connecting rod and the crank arm, due to lack of space, but hydraulic pressure could be used as the tube for it would require but little space.

The practical realization of this variable-pitch propeller appears to me to be quite a substantial job which would require time and money before results could be obtained with it. But there is a possibility that the mechanics who know what has been unsuccessful, could point out what to do in order to bring your invention to a success.

Let me know which of your inventions you want to be considered first. We have already the lubricator and the airplane on hand, and it is not good to handle too many things at the same time.

Very truly yours,
O. Chanute

June 16, 1892

413 E. Huron St.
Mr. L. P. Mouillard

Dear Sir,

Mr. Whittlesey writes me that the Patent Office refuses to admit the novelty of your lubricator and points out to us not only the patents of Gregory (303,999) and of Freeborn (429,125) which you already have, but also those of Laval (280,913) and of Owen (212,500) which I am mailing you under separate cover.

The Patent Office tells us the "Gregory's as well as Freeborn's pipes could be applied to the keel without forming a new invention, and that oil could be distributed by means of Owen's pipes without novelty of invention."

We could change our application a bit to get a compulsory patent by way of placing the pipes, but it would have little value.

It seems to me that Owen's patent is the hardest to get around. As he lives in Washington, and as I suppose that he (as most of the inventors) has been unable to get any benefit out of his patent, I asked Mr. Whittlesey to call on him and to find out how much he wants for it. This patent is of no value by itself, but combined with your own and with General Hutchinson's, which I mentioned to you, it may have some value.

We have to go slow with Mr. Owen or else he may get an exaggerated idea of the value of his patent which dates back to 1885. Mr. Whittlesey writes me that he is making inquiries about Owen and that he is going to have an interview with him. I shall keep you posted on the negotiations and I would be pleased to know what you think of Owen's patent.

I believe that in England and in France patents are issued to anyone who applies for them and then let the inventors fight it out among themselves as to the novelties of their ideas. In the United States they try to protect the inventor and no patent is issued unless the idea is: 1st, new, 2nd, useful. If an inventor has previously conceived an idea which another inventor tries to use in his patent, the latter's application is rejected or else it is properly limited.

Very truly yours,
O. Chanute

Note change of address - 413 E. Huron St.

413 Huron Street
Chicago
June 17, 1892

Mr. L. P. Mouillard

I still owe you the description of my observations of gliding flight in California.

Gliding flight is not exactly new to me. I had already observed the small vultures in Louisiana and in Texas, and I knew that with the help of the wind, they directed themselves in the air without flapping but they usually kept themselves so high that I could not see their evolutions in detail.

The sea gulls of San Diego, on the contrary, are well tamed. Nobody bothers them because they clean the refuse from the boats and when a steamer arrives they assemble to watch the kitchen. The sea breeze blows every day and they make glider flights at 5 meters from the bridge while waiting for the clearing of the table.

So one can observe them perfectly, measure their speed and that of the wind, estimate the angle of attack, and observe their slightest movement: at eye level, above, below, while flying away, in full flight, equilibrating themselves, and in resting. One sees their eyes, their claws, and the least little piece of down that quivers in the breeze.

My best observations have been made from three bridges of the steamer docked at the wharf. The distance was from 30 m to 3 m from the wharf and the sea gulls made a half turn at each end.

The wind blew at an angle of 30° with the speed of 5.74 m per sec, and the birds glided without flapping at a speed of 3.05 m per sec relative to the boat, but of 8.02 m per sec relative to the wind. It means that at the angle of 30° the speed of the wind was 4.97 m per sec, and that of the bird 3.05—total 8.02. The angle of attack was 5 to 7° above the horizon. The birds weighed about 1 kilogram and presented a shadow of 0.18 square meters. Their wings were arched below and, when a rain would come, they either balanced with their wings or they carried their head in front, in back, or sidewise, or in grave cases the feet generally folded under the stomach, or they went down to the wanted angle to re-establish the compromise equilibrium.

It is very probable that for larger birds the equilibrium is much more stable; but I was very much struck by the nearly continuous efforts that the seagulls made to maintain a good line under the buffeting of the wind. These efforts are nearly impossible for a machine without living guidance. And I asked myself whether an automatic arrangement could be developed to redress

without intervention of the individual the irregularities of an aerial flight.

Here are my observations on the maneuvers that I have seen made by the seagulls.

The Departure (Take-off)

They leave from the water or from where they perch. If it is from the water, they put their beak to the wind, jump into the air, and begin to row vigorously against the wind, advancing nearly horizontally. The flappings are very ample and of three per second, but after seven to ten meters the amplitude is less and the flappings go down to two, and then to 1 per second, the bird rising at an angle of less than 45° to about 10 to 30 meters above the water. This elevation that needs a course of 50 to 70 m permits him to enter into gliding flight with an acquired speed of 6 to 9 m per sec.

If they are perching, and they seem to prefer to pose themselves on the roof or a pile, the effort of departure is much less and can be made without flapping by throwing themselves toward the water until the gravity gives them a speed of 8 m per sec, at which they can elevate themselves on the flight and start to glide, if the wind blows at 5.74 to 6.26 m per sec.

If the breeze is regular and of 7 m per sec, the bird can leave even more easily from the height of a roof or a pile. He goes with the beak toward the wind, opens his wings very wide but a little inclined below the horizon at the front edge, then changing suddenly this angle of attack above the horizon, he rises while flapping against the wind. So he arises from 0.60 to 1.00 m, but nearly at the same time he goes down 1 to 2 m, and then he changes his angle of attack again downward, plunges into the wind, and is now in full gliding flight.

All these maneuvers are perfectly comprehensible; the bird tries by flapping or by falling to give himself a speed over 8 to 9 m per sec, and if the wind blows from 5.74 to 7.00 m per sec he does not need much effort. He can travel broadside or windward at different angles of 30° to 60° with the wind or rise in turning around when the wind is feeble to head himself so as to utilize the acquired height and go where he wants. When the wind is too feeble, he either stays on the perch, which is preferable an isolated wharf "where one can walk and talk with one's friends" or he flaps with a speed of 9 to 10 m per sec. All these speeds have been measured exactly.

Gliding

The gliding is most often horizontal; the bird does not seem to want to get away very far from the place he surveys, be it a boat or the water. He generally glides at 10 m from the water and from time to time launches down to catch a morsel. I have been able to see these maneuvers from very close when he goes down and when he goes up, but most of the time he is obliged to make some flaps and that would not interest you.

But I have seen some curious evolutions at San Francisco. The sea gulls follow a steam ferryboat in gliding and catch in their flight morsels of bread thrown into the air. Of 70 morsels they caught 53 in the air and you may imagine the acrobatics that resulted.

A great deal has been said about the ascending winds, and with a wind rising from 6° to 10° on the horizon, one can do mathematically everything one wants with a bird. I wanted to be sure of that, and I found out in throwing small pieces of paper on the bridge of the steamer of which I told you that the wind was slightly ascendant on the side from which the wind came. I also found out that when the breeze was feeble the birds glided preferably with the wind at the side of the coal shed of 200 m long to 10 m high, where there must have been an ascending wind but that, when the breeze was of 7 m, they went everywhere indifferently. I concluded that the ascending winds helped the bird when the breeze was feeble and when he made certain strange maneuvers like those of the eagle advancing and rising against the wind (p. 22) but that the ascending winds were not at all essential to gliding flights.

Equilibrium

I have already touched on equilibrium. It seems to be that birds are accomplished acrobats. The angle of attack changes continually with the needs of flight, and by this same token, instinct changes continually the lifting surface, the position of the head and the feet, to make the center of gravity coincide with the center of pressure. I have doubts about the spring with the little spacing and I ask you (1) to explain it more fully, as I have doubts on the subject.

Landing

The bird stops his impetus, if not in sailing at least in ascending against gravity by opening his wings very wide, throwing himself toward the back at an angle of about 36° and pushing back the air against the wind. He is stopped, he balances a moment about $1/2$ m from the perching point, and he falls on it nearly vertical. That is a maneuver very difficult to reproduce with an artificial machine and it seems to me the problem of the landing is one of the most serious one to be resolved if one has no flapping or rotating surfaces to flutter a moment as the bird does when his impetus is not sufficiently arrested.

Soaring Flight

It seems certain to me that some birds can perfectly well gain from the wind, if it sufficient for their particular conformation, their weight and their surface, all the motive force necessary to take-off, to spend the day in the air, to ascend and descend, to go sidewise, and to return home without a single flap.

In order to reproduce this flight is is nearly indispensable to explain it physically, for the danger is great if one neglects one single element. I think I understand take-off, equilibrium, and landing, and I am able to demonstrate them mathematically although the latter two are very difficult to reproduce with a lifeless machine. I am not sure, however, that I completely understand gliding. It seems to me that the impulse is received when the bird presents a side to the wind just as in the broad side of our ice boats that tack across the ice "in the eye of the wind" with a speed of 100 km per hour, when it blows 35 km per hour. I think that with the wind in the rear the bird descends a little to maintain its speed greater than that of the wind; without that he would not be supported, and that with a head wind he ascends in consequence of the composition of the two speeds (one of the wind and one of its own) but that he loses a little of this latter speed.

I still ask myself why some birds are able to soar and some others of the same size do not at all. Why, for example, our turkey buzzard is a good glider and our wild turkey is not. This latter bird can glide using the acquired speed but it cannot borrow this speed from the wind. It seems to me that it must depend on the form of the wings and especially of the lower front surface and that with the plane surfaces which you propose you will not reproduce gliding flight; that there will not be "aspiration." The sparrow hawk, the turkey buzzard, and sea gull, the three gliders that I know, have the wing curved below making a hook

while the wing of the turkey has simply an enlargement that contains the bone and the muscles.

(2) Please tell me your observations on this subject, and tell me what form you propose for the front of your airplane and the lower surface. I believe that is of prime importance.

I seem to see mathematically that, if the fringe of the wing is curved into a hook, the horizontal component of pressure will be directed toward the front just as if a plane wing were inclined to the horizontal; if that is so, a wing of good curvature can be placed above the horizontal, create lift and, at the same time, "the aspiration." I am about to make experiments on this subject.

(3) Have you written the article for the Cosmopolitan?

Please answer especially questions (1), (2), and (3).

Sincerely,

O. Chanute
413 E. Huron St.
Chicago, Ill.

Note the change of address.

Cairo
July 1, 1892

Mr. O. Chanute
Chicago

My dear sir,

I herewith enclose two letters which I received from Paris in reference to my book. According to Mr. Hureau de Villeneuve, I could do the proofreading myself, the shipment back and from of the proofs would cause a delay of only twenty days.

I have to write him again to ask him for the address of a printer outside of Paris who could do a less expensive job.

I am also consulting the Bottin * about the price.

I am still waiting for the report of the observations you made during your trip to the West.

With a cordial handshake I am

Your devoted
Mouillard

*Bottin is a general Directory wherein may be found all sorts of valuable information about the residents of the city; their home and business addresses, office hours, and, apparently, their printing rates.

Paris
June 24, 1892

Mr. L. P. Mouillard

Dear Sir,

I received yours of June 11 in which you asked me to take care of the proof-reading of the book you are about to publish.

A few years ago I would have accepted your proposition, but now I have little time for aviation in order to devote myself solely to medicine. Well, you know that the medical profession is very engrossing and leaves very little time at one's disposal. Therefore I lack the time necessary for reading your proofs. The work would be poorly done and you would have reason to be reproachful.

It would be better if you select a young man, or better yet if you have the proofs sent to you to Cairo. The expense for postage would be easily recovered by the savings you would make in this way.

It is certain that it would be more economical for you to have the printing done at your own expense. As soon as you have the money ready you could get in touch with a printer outside of Paris who would charge you half of what you would have to pay to a Paris printer.

Very truly yours

Abel Hureau de Villeneuve

Enclosure
 G. Masson
 Libraire de l'Academie
 de Medicine
 120 Bould St. Germain
 Paris, June 22, 1892

Mr. L. P. Mouillard

Dear Sir,

Enclosed please find the statement you requested. I have gradually reduced the money to be paid in advance and owe you now 10 francs.

Below you find the estimate of a volume of 300 pages without illustrations similar to the first one and to be printed in 500 copies.

But be it well understood that this is not a contract but rather an estimate.

(Signed)
 G. Masson

Estimate of a volume in 8° of 320 pages (20 signatures) similar in type, print and paper to "L'Empire de l'Air" - printing 550/500.

Composition of one signature, printing of 500 - paper and glazing - 62f.

There will be 20 signatures at 62 f.	1240 f.
Cover in 2 colors	46 "
Stitching	65 "
	<u>1351</u> fr.

This price does not include the picture which would cost from 10 to 20 fr per page according to its size, neither proof-reading, nor annotations, if there are any.

It would be well to figure on a total expense of about 1500 francs.

Paris
August 1, 1892

Dear Sir,

Our colleague Dr. Hureau de Villeneuve must have told you that at the meeting of the S.F.S.A. on July 7th I agreed to correspond with you and to do the proof-reading of your new book on "L'Empire des Aires."

Various other obligations, especially the signals for aeronautical use which have been put in operation on July 10, by means of the Electric Semaphores of the Channel, prevented me from getting in touch with you earlier. I do it now by sending you under separate cover a pamphlet titled "Air Navigation in 1899" and this sample of my very poor handwriting.

Both, at least, may show you my love for "aeromania" (aeronautic hobby) in which you have taken such an outstanding place, also that I may do as a proof-reader, at your service.

I shall do this work without remuneration. All I ask are two unreasonable requests, as follows:

1.) That you would be kind enough to present me with a copy of your "Empire de l'Air."

2.) That you allow me to add to your new book a commentary as Captain XXX did to Dr. Marcy's book on "Le Vol des Oiseaux" (The flight of birds) 1880. This supplement will be titled "The laws of aviation" and when printed will have about the same size as the pamphlet I am mailing you. Printing expenses to be paid by you and I shall surrender all other rights of authorship. In case I should get the foolish notion to have a separate printing of it made, this would be at my expense.

With this appendix we could have some preliminary remarks either by Dr. Marcy of the Institute or by Mr. Jaunsen of the Institute and I have the fatuity to believe that your book would not be impaired by either one. Hoping that such a presumption does not leave an unfavorable impression of me in your mind, I am

Very truly yours,
Ch. Labrousse
Lt. of the French Navy retired
Member of the permanent civil
committee of Aeronautics, etc.
25 Avenue de Friedland

July 1, 1892

413 E. Huron St.

Mr. L. P. Mouillard

Dear Sir,

Enclosed please find a translation of a letter which Mr. Whittlesey received from Mr. Owen whose patent for greasing ships while in motion by means of air I mailed you.

Evidently Mr. Owen indulges in illusions and we shall have to pass him up and take out the best patent possible for your invention, with a view on previous patents.

I shall be glad to get your opinion on this subject and some suggestions on the best way to follow. As I have already pointed out to you from California we have to expect a more or less long struggle before success may be realized.

I am busy to get from General Hutchinson, of whom I have told you, ownership of his patent for the United States. He keeps the French and English patents.

Very truly yours,

O. Chanute

P. S. I received your letter of June 16 and I shall answer within a few days.

Washington
June 27, 1892

Mr. C. P. Whittlessey and his client

Gentlemen:

I have your letter of June 15. Yes, I still own the patent for greasing the hull of ships and I appreciate perfectly the importance of my patent and my invention. I have made experiments and have had some letters about them also an interview with the owner of a similar English patent. A famous designer on the Thames River has also made some successful experiments and says to have obtained 30 miles (48 kilometers) per hour.

At present I am preparing drawings for a high-speed boat for New York and the patent may have a great value for this object.

May it suffice to say that a single series of experiments have been made in this country with an open pipe in the rear, and that my experiments have been the first ones with an enclosure parallel to the keel which distributes air all along the ship.

My experiments have a value independently of that of my patent.

As to that value, if there is a chance to reach an agreement it would be better if your client made me a proposition at which I would not mind at all to ask for any price before having gotten results of my actual designs.

I thank you for your inquiry and hope to hear from you again.

Very truly yours
Fred D. Owen

July 4, 1892

Mr. L. P. Mouillard

My dear sir,

I received your kind letter of June 14th and I think that my letter of June 17th should give you a better explanation than that of May 20th of what I wanted to say by asking you whether you figure to create suction with surfaces which are flat underneath, without losing altitude.

If I am not mistaken, the master, the bird does it with slightly concave surfaces. However if you have made experiments which show that suction is possible with entirely flat surfaces, I kindly ask you to let me know the results.

Moreover nothing is easier than to get concave surfaces. All there is to know is which is a good curvature and the best way to get it. If it is done simply by means of the wind pressure, I think that the structure of your wings should be modified so that the main arm is at the leading edge.

My letter of June 17th must have shown you that I have no doubt whatever of the possibility to reproduce gliding, but wish to know only of the conditions under which it may be done.

There is another point about which I want to talk to you. Should not the airplane have a speed of its own in order to advance against the wind? I am uncertain about it. Your eagle (page 22) took off by dropping two or three meters. The gull which I described to you started to drift when rising from the pile at the beginning of its flight, which is easily explainable as being due to the disintegration of forces. D'Esterno and Capt. Lebris said that a preliminary impulse is indispensable. I imagine it is similar to flying in spirals, because with the wind in the rear the speed should be high enough to create lift by means of a relative speed which is the difference between the speed of the bird and the wind velocity. But with the wind ahead could the airplane rise and move forward at take-off?

It seems clear to me that it could rise while drifting then plunge into wind and so get a relative speed with which it could rise again and glide; but this is a delicate maneuver.

Yet something else: As a ratio you gave me a load of 5 kilograms per square meter. This is a good ratio for cross country which may even be reduced to 10 kilograms per square meter for high speeds. However arrangements cannot always be made to land in water. For a parachute landing there should be at least a surface which is loaded by 1.25 kilograms per square meter. What ratio do you recommend for the experimental airplane?

I shall keep on sending you my articles on experiments which have been made, and while preparing them I have read with great interest all patents I could get of machines of which Dieuaide's illustration gives a very imperfect idea. Almost all inventors consider two kinds of control and most of them propose a tail with variable angle for vertical control and a control surface below the tail (which the illustration does not show at all) for horizontal control. I believe, for the latter control, your proposition to be far superior to the other control surfaces, but I am not absolutely certain whether safety does not require a tail with variable angle to act as an automatic control surface of the airplane. I believe the soaring bird uses its tail as well as forward and backward motion of its wing tips which you have reproduced, so well and which I consider as one of the most successful characteristics of your machine.

D'Esterno proposes something similar. In the first edition of his book he presents an airplane, the wings of which rest on a pivot in front to allow them to be moved forward and backward; in the second edition this design is omitted and it seems that in his patent he found out that this motion is too difficult to reproduce, because he did not patent it at all, a fact for which I sincerely congratulate you.

D'Esterno's machine was meant for gliding, but in his patent he gave in to prejudice, and having placed his wings on two shafts which made it possible to bring them in a V position he spoke of the possibility of flapping wings, without referring to an engine whatever.

Du Temple's machine had below the tail a control surface with an independent motion. The machine was equipped with an engine, but Du Temple was also thinking of gliding. The wings could be moved forward or drawn backward by letting the rods which were attached to the nacelle slide one below the other. However this could not be done while the machine was in motion.

As to your book, do I understand correctly that your loss on "L'Empire de l'Air" was 2400 francs or that this are the printing costs which were reimbursed to you by the sale of the book. I am willing to advance the printing expenses as soon as your interests are covered by patents, but the new book should bring in its initial cost. At any rate get all the information necessary and let me have it. However, I think it would be better to have some sketches in the text so your ideas are better understood.

I am sorry that you have approached Mr. Hureau de Villeneuve. I believe him to be very jealous of everything which does not come from his shop.

If you have a chance, have my articles on the airplanes translated. You will find in them some strange tales of experiments which have been carried out.

Very truly yours

O. Chanute
413 E. Huron St.

Cairo
July 10, 1892

Mr. O. Chanute, Engineer
Chicago

My dear sir,

Here are the answers to the questions you asked me.

As to the lubricator and the decisions to be made on this subject, I kindly ask you to do the best you can. You know I rely entirely on you, and anything you do will be well done.

You may tell Mr. Whittlesey that I have experimented only with a small model of this airplane. I have seen this one-piece wing system in operation on the puffins and the swifts.

In reference to my propeller I kindly ask you to read the chapter again when your mind is relaxed, if possible in the country where you will be free from care. I think you will better appreciate the organ which actuates the wind because I believe you will find out that there is the trouble. I think you are going to change your viewpoint. You ask me what I want to have patented first. Answer: Anything which may be quickly transformed into money. This would enable me to meet you as soon as possible, so that I could explain to you orally those matters which are not so easily understood in letters, as one hour of conversation is worth more than a written volume.

In your letter on aviation is a question which puzzles me and I want to answer it first. I do not know the Cosmopolitan Magazine and I did not write an article for it. Besides I only write to you on aviation. You would greatly oblige me if you could tell me more about this article and if it is worth while to be kind enough to send it to me.

Let us pass on to the airplane. Naturally, the spring alone is not strong enough for the completely automatic adjustments for vertical equilibrium. Unquestionably it could not move the wing tips forward by itself; it therefore should be allowed to react without being forced either by the hands or the feet so as not to require more power than necessary to move the weight forward by letting it act freely in its own fashion. Left to act by itself, it will assist the maneuver in a precise manner and will succeed in giving the necessary angle at the right moment. For the opposite motion (the wing tips are somewhat forward, kept this way by the ropes that are actuated by the legs and the hands, because a wind of 10 meters is to be overcome); if in this position the airplane unexpectedly strikes a rapid wave, let us say one of 15 meters, the spring will automatically produce the useful angle. When this wave has passed, the craft will again automatically take the position for a wind of 10 meters.

This spring of a well-calculated strength will be a great help in the production of vertical balance. I do not dare with all discretion to assign to it a more important function than the one just indicated, but I believe it to be a device that will produce more than I indicated. The bird, moreover, possesses it; it is again a copy, simplified it is true, but I could not find a better one unless I entered into complications that a trial airplane could not utilize. With the bird there are springs that oppose deflection; they are the series of muscles that extend from the wings and a counterspring designed to stretch the skin that unites the arm to the forearm. It is this counterspring that produces the curving of the front of the wing; curving that has made all the aviators dream so much and of which I am certain one can get along without, as has been proved to be by the thousands of airplanes large and small that I have seen function.

Moreover, I propound herewith a principle that is not in my book but over which I have been pondering for years, namely: The less hollow the wing is in its active part (the hand), the longer the flight will be. May I assure you that I have studied this problem carefully. Besides I am going to write a paragraph on this subject to be added to my book because this subject is of great interest. As I do not think you are in a good position to study this ornithological problem, I kindly ask you to take my word for it, and I assure you that I am not mistaken.

From theoretical considerations, this curvature is of little interest. A flat surface and a curved surface function in almost the same manner. In the curved surface, pressure and suction are equal. On the flat surface, many knotty problems caused by transient pressures are somewhat troublesome, especially when the surfaces are very large and the speed is very high. But this question belongs entirely to the highly developed stage of flying and is unimportant in our case. Considered from a practical viewpoint, however, the matter is entirely different. When at rest, the wing should be as follows:

Section at the elevation of the elbow

Section at the elevation of the wrist

Section at the center of the remiges

This arrangement is indispensable, as my experience has proved. When after careful consideration and after studying the large birds, I proceeded to build a large wing whose section at the remiges was:

Front Rear

I made use of a good wind to try its action. The wind showed me at once that I was wrong. The front made a beautiful plunge that, when properly considered, was natural. The surface between 1 and 2 was exposed to a pressure and this pressure deformed the wing tip in proportion to its moment, because it is hard to make this tip rigid; in short, the aviator would have taken a header if the craft had been manned. I had given in to the common belief and pure theory had created this masterpiece. By a reconsideration of the situation, a conclusion is quickly reached that this plunge must be prevented by all means and that, on the other hand, a constant lift must be created. This lift may be obtained by the manner I have previously stated. Next, I examined the large birds and I noticed that when they are at rest (I am assuming that the remiges are clipped 2 inches from the tips):

Great horned owl

Large vulture

when under pressure (the feather under the weight of the bird and under stress) produced the following arrangements:

As you may notice, the loaded wing becomes a horizontal surface, or a series of horizontal surfaces which is the same thing.

I come now to the impression expressed throughout your letter that there is a lack of the power of action. These acrobatics frighten you. Man will never be nimble enough to produce them. You reasoned that the bird is endowed with this agility and the aviator is not.

This impression, which I consider to be perfectly correct, was imparted to you by the species of bird you studied. According to what you wrote me, you observed the gull and the turkey buzzard. What is the latter bird? Probably cathartes aura or cathartes urubu; it certainly is one or the other. I know the structure of these small American vultures; I observed some ten of them at the Jardin des Plantes (Botanical garden) in Paris.

They fly well but are by no means experts in the type of flight which I extol. These birds weigh less than 1500 grams; this mass is not sufficient to produce the effects of penetration and stability of which I speak in my two books; furthermore they lack the aptitude for such a flight. If, instead of these three larks you could have seen the condor for only five minutes you would be enlightened with the truth of what I have described.

As you probably do not intend to return to California within the near future and as it is however necessary that you convince yourself that I do not exaggerate, resort to experiments. Make 4 or 5 airplanes which have a span of 0.50 meters, 1 meter, 2 meters, 5 meters and 10 meters. As soon as they fly correctly in still air, let them fly in turbulent air and you at once will have the desired demonstration.

You will notice that the small airplanes are being upset, deviated and pushed back by the air current; you will understand that, in order to keep them on the correct course, they must have more activation the smaller their mass. On the other hand you will see how the large and heavy airplanes move majestically in the direction they have been launched, showing by no motion whatever that they are affected by the action of the current; in other words they produce the quiet imitable flight which I have described as being that of the great vultures.

For this reason I urged readers again and again to study the very heavy birds in order to be convinced of the possibility of reproducing their flight. I expressed this on pages 217-218 and at the end of page 73 and in many other passages. I even say that a bird weighing less than 2500 grams should not be considered for observation because it tends to show that in order for flight to be accomplished there is required a sum of expendable energy which one cannot dream of producing.

With a cordial handshake, I am your devoted

Mouillard

July 25, 1892

Mr. L. P. Mouillard

Dear Sir,

Enclosed find application, description and affidavit to be executed (same as the last time) for your airplane patent. Please return them to me as soon as possible.

I also am sending you 500 francs for outlays which you may have to make.

In order to make a good description Mr. Whittlessey has put in some time. I have made a literal translation of it for you, hoping to give you in this way a more exact idea of it; but I notice that I made an atrocious job of it and would have done better by adhering less to the wording. If there are some obscure points, please have it translated from the English.

Please indicate with pencil on the English text of the description the changes and amplifications you wish to make and I shall have it rewritten by Mr. Whittlessey before delivering the papers to the patent office.

The important matter in an American patent is to claim exclusive propriety of everything new in the invention. Mr. Whittlessey has enumerated 24 claims which have to be fought out with the patent office. I doubt whether we may obtain the three provisions, but we shall see.

Very truly yours,

O. Chanute

July 30, 1892

Mr. L. P. Mouillard

I received the English patent from General Hutchinson who cedes to you the rights for the United States. He is willing to sign the necessary papers provided that this translation does not involve any expenses on his part.

However, he wrote me a letter, dated July 15th.

"I received your letter of the 2nd, and according to your request I am pleased to send you my "specification". Yet I warn you, as a friend, not to venture any money in this enterprise, unless you could add some chemicals to the oil in order to prevent the formation of algae.

"I have given up all hope of success. One of my sons who took part in the aquatic sports at Oxford University told me that they often tried out boats with greased hulls without any better results.

"Admiral Scott a well-known mechanical engineer who invented the carriage for large guns, was very enthusiastic about my idea. He had it tried out by his son who owns a yacht; but the test was a complete fiasco.

"After all this seems logical to me, when one recalls that a drop of water which falls on a wet board will run down when the board is inclined, but on a greased board which has the same inclination it will adhere".

Very truly yours, etc.

It has to be found out whether the General is right. He says in fact, that the coefficient of friction of water on water is less than that of water on oil. I do believe this; but is the coefficient of water less on iron or on wood in their regular state than on the same materials when they are oiled? This has to be established and I am going to go to New York in the near future to learn more about the results of experiments a friend of mine is making this summer.

At any rate I would like to have your view on this matter and to find out whether you think it would be better to give up the idea to take out General Hutchinson's patent in the United States. Besides it is the same as the one for which we have made application in your name with the difference that he puts his pipes vertically and flattens them out to decrease frontal resistance.

Very truly yours,

O. Chanute

99
August 2, 1892

Mr. L. P. Mouillard

Dear Sir,

I found your letter of July 1st when I returned from the country. I shall lend you an amount to the extent of 2500 francs for printing your book, against your note to become due in one or two years at 5% interest. I believe that the sale of your book should realize the necessary amount.

I think Mr. Hureau de Villeneuve gave you a good advice when he told you to have the printing done outside of Paris and to proof-read it yourself.

As to the illustrations I urge you to insert all which are necessary to make your general ideas well comprehensible. It would not be right to spoil a book in order to have a little money; besides, it would hurt the sales. I also advise you to print 5000 copies; this would cost paper and printing only, and I believe, with the impression your first book made, you should be able to dispose of them.

Concerning the number of pages, I would not try at all to fill 320 pages. At my opinion it would be best to tell all you have to say about flight without flapping wings, and then stop.

Furthermore, I would advise you to fix the sales price higher than usual. You are dealing with a special and limited public, and those who are interested in the problem will pay 7.50 francs or 10 francs just as likely as 5 francs. However, I confess that the opinion of a bookseller would be much better than my own; but ask one because if you have the book printed at your own expense you would not be able to allow the dealer much of a discount. I estimate that the copies will cost you 3 francs each if you print them in lots of 500, and less than 2.50 francs in lots of 1000. You should be able to sell the book to dealers for 5 francs.

Because the aim of this book is to make known your ideas of gliding flight, it would not be prudent to publish them before the patents for which we apply have been granted. So please let me know in which countries you think it advisable to apply for a patent on your airplane.

It will take all of six months to have a patent granted in the United States, but we may retain the secret for six months more, as I explained to you. Before going into any expense in other countries, it would be a good idea to make some tests, to be sure that you are not mistaken, and also that the machine will not only rise but will move forward. I consider this feat to be possible, but please answer this question: Did you ever create suction without preliminary propulsion on a model or any machine whatever?

I also kindly ask you to give me any information you think to be useful, so that I may proceed with experiments on the airplane.

Very truly yours,

O. Chanute

August 9, 1892

Mr. L. P. Mouillard

I received your kind letter of July 10th and mailed you three copies of the Cosmopolitan Magazine which contain some articles on air navigation.

This magazine devotes itself to this subject and has requested me to contribute some articles. The proposition had been broached to ask you for one on gliding, and I understood, according to a letter from the editor of March 23, that he had already written you. I do not know why he has not done so, but I am going to New York shortly and will get some information verbally. The magazine pays from 250 to 500 francs for an article of from 3000 to 4000 words and prefers that it includes some illustrations.

As to the conversion of your inventions into money, I am afraid that this will take quite some time. Everyone of them has still to be applied to practice, and sometimes it takes years to develop an idea into a new machine. As a start I selected the lubricator because it looked to me to be the most simple thing and yet you see that it is not as simple as it seemed to be. I may have been wrong and I therefore ask you again to tell me which invention you think may be converted first into money.

It seems to me that your best bet is the airplane I am willing to spend some money to experiment with it; but first of all I want to get a clear idea of the results to be expected. Right now I think you are wrong when you say "that the curvature in front could be dispensed with" because all my experiments with flat surfaces showed that they rise backwards. Yet I would like nothing better than to be convinced to the contrary.

You have a somewhat wrong impression about my idea of the power of action of man. I simply believe in the necessity of having an airplane of a more stable equilibrium than that of birds, because the pilot must give all his attention to control.

You refer to experiments to be made with airplanes of a span of from 0.50 meter to 1 meter and 10 meters. Will you kindly give me some instructions of how to build them properly. I do not understand very well the "correction fold".

Very truly yours,

O. Chanute

August 19, 1892

(Letter from L. P. Mouillard to O. Chanute is lacking)

September 1, 1892

(Letter from L. P. Mouillard to O. Chanute is lacking)

September 12, 1892

Mr. L. P. Mouillard

Dear Sir,

I received your letter of August 19, which contained your patent application and I forwarded the letter at once to Washington; at the same time my letter of January 17th has been returned to me from Cairo, marked "Unclaimed".

There is evidently some carelessness on the part of the Cairo post office and it would be better if you would give me a more definite address, if this is possible.

As there is a possibility that some more of my letters went astray, I herewith give you a list of those I wrote you since January 1, 1892.

Jan. 16 - Experiments with the lubricator in New York, etc.
 Jan. 17 - High speed train etc. - enclosures
 Jan. 27 - Ms. to Mr. Langley - Patent for airplane, Hutchinson's lubricator, etc.
 Jan. 31 - Mailed you application blank for the lubricator patent.
 Feb. 11 - En route to California - What inventions do you want to have patented, etc.
 May 20 - Acknowledged receipt of airplane drawings - suction

I also wrote you from California but I do not remember the date.

June 16 - Question asked by Mr. Whittlesey, etc.
 June 16 - Difficulties to get the lubricator patent
 June 16 - Report of my observations in California
 July 1 x - Difficulty Owen about lubricator
 July 4 x - Suction with flat surfaces; is preliminary propulsion necessary?
 July 25 - Mailed application for airplane patent
 July 30 - Hutchinson's patent etc.
 Aug. 2 x - Publication of "Vol sans Battement"
 Did you create suction with a machine?
 Aug. 9 x - Cosmopolitan Magazine. Various inventions - Conversion of them into money? Experiments to be made.

I have no reply to those marked with an x.

I am returning to you Mr. L's sugar-coated letter and I warn you not to enter into any business relations with him. I was told in Paris that he is one of a small group which lies in wait for somebody else's ideas. Let the correspondence slowly come to an end and never tell him that you intend to apply for patents in case the preliminary experiments are successful. Yet you may tell him that Mr. Langley has your book at present and, as he is in Europe, you cannot get it back until he returns home.

Very truly yours

O. Chanute

October 1, 1892

Mr. L. P. Mouillard

Dear Sir,

You wrote me several times to have the patents issued in both of our names, but Mr. Whittlessey thinks it would be better to take out the patents in your name alone, as original inventor, and afterwards you cede to me half of them, according to our agreements.

I am enclosing agreements for the patents of the lubricator and the airplane, together with a translation of the latter. These agreements have been prepared by Mr. Whittlesey. They are in duplicate and you are to keep one and to send me the other after having it signed and notarized by the U. S. Consul.

I did not receive any news from you since your letter containing the papers for the airplane, and you owe me several answers. I am going to New York soon where I intend to devote myself to your log and your propeller.

Sincerely yours,

O. Chanute

TRANSLATION
Agreement concerning the airplane

Whereas the undersigned, Louis P. Mouillard, citizen of the French Republic, residing in Cairo, Egypt, has invented certain new and useful improvements in the methods of air navigation for which he has applied for a United States patent on Sept. 4, 1892 the order number being 416,786, and whereas Octave Chanute of Chicago, Cook County, State of Illinois, desires to acquire a part in this invention and in the patents which may be obtained for this machine in the United States as well as in other countries.

Therefore this agreement affirms that in consideration of the sum of one dollar legal tender of the United States of America, received by me and also in consideration of the fact that said Octave Chanute is to pay all official taxes and fees and all expenses for legal services rendered necessary to obtain said patents, and each of which in accordance to these expenses to be made, I, the undersigned Louis P. Mouillard agree to assign, sell and remit to said Octave Chanute, his heirs or representatives a joint half of my entire right, propriety or interest in said patents for the United States, as soon as it is issued, also in the patents of all other countries when they will be issued, agreeing to sign all papers necessary to invest the said Octave Chanute, his heirs or representatives with the title of the above mentioned joint half of the invention and of the patents.

Above all I agree that this agreement shall be binding for my heirs administrators or representatives..

In testimony whereof I affixed my signature and private seal.

Cairo
October 8, 1892

Mr. O. Chanute, Engineer
Chicago

My dear Sir,

I herewith confirm my two registered letters of Sept. 20.

I received your kind letter of Sept. 12th also that of January 17th. I checked the list you sent me and find only the latter missing.

I cannot give you another address, because the streets, for the most part, have no names, yet there are letter carriers who deliver the mail to the homes. It is unnecessary to tell you that I complained in a way that a similar error will not happen again.

Generally the mail service is rather accurate; during five years while I was director of a large commercial house I received several letters a day and none ever went astray. The letter mentioned above was delivered to the Cook Company, probably because it came from the United States, and there are many American tourists on the Nile.

I am going to answer your letter which went astray. You do not want to believe that, in order to move successfully, the long side should be in front. Yet, I have tried to make this comprehensible, but nothing is better than a direct proof. You could make this test easily. Build a plain boat, i.e., a simple piece of light wood which is shaped according to the plan I propose. After this shape has been produced, varnish the wood ballast. so it floats a little, by means of a metal keel which will hold it in a good position in the water; then launch it in the water so that first the long side is in front, where at my opinion it should be, and then with the long side in the rear and compare the distances which have been covered. It is evident that the water and the same manner of execution should be sufficient for both experiments. This is very easy; you may have access to some body of water; a well-shaped piece of wood, 1 meter long, should demonstrate the difference of the penetration capacity. As to the observation of objects intended to cut through water or air, look attentively and you will see that I am right; but I admit that observation is infinitely more difficult than experiments. Therefore you should devote yourself to the latter, in order to convince yourself.

When you are convinced you will have faith: in the high-speed rail road, in the boat, and in everything which has this shape. You will then notice also that all modern ship designs proceed slowly toward the mass to the rear so that in order to cut through fluids successfully a long front is required, and that this is the way to do so. You then believe the prophet who never experimented himself because his means did not allow it, but who instead watched the experiments of the "master mechanic" (nature) and benefitted from its manifestations. I have seen creatures which are so fast in the water that the fishes look like unanimated floats which do not seem to move. I saw how this paradoxical creature was built and from this study I copied the shape which nature prefers for swift motion. If I am wrong, I am in good company. As you see, dear sir, I probably am right, so convince yourself by means of this little experiment.

Now I come to the airplanes. Here also you give no kind reception. You do not believe completely because you have not seen, and here also palpable proofs are necessary.

I think it would be well to convince you of the gliding capacity by sending you something small which should make you ponder. It is a small paper airplane I have built and which I am going to send you by parcel post. I hope it arrives undamaged. If so you may note that it has a gliding angle of 10 degrees (in a room). At the same time I shall give you directions of how to use it.

In referenceto my two last letters, my torpedoes, I recommend them to your consideration. I kindly ask you to give them your full attention. This is a serious work which, without impertinence, should not be treated lightly.

With a kind handshake, I remain

Your devoted

Mouillard

P.S. Thanks for the information of Mr. L. - I acted accordingly.

October 23, 1892

Mr. L. P. Mouillard

Dear sir,

On my return from New York your letter of Sept. 1st was awaiting me, also the letter which contains a description of your torpedo. I shall take this matter up with you after I have examined it with all the care it deserves.

Mr. Langley whom I have seen in Washington is at present preparing a summary of "L'Empire de l'Air" which he expects to publish in the collections of the "Smithsonian Institution" and for which he intends to remit to you 250 francs. I have accepted his proposition in your name. Perhaps he will do likewise when "Vol sans Battements" is published.

Mr. Walker the editor of the Cosmopolitan Magazine, of which publication I have sent you several copies, authorizes me to offer you 300 francs for an article of about 4000 words on the flight of birds, and some illustrations to go with it. You could either compose this article from excerpts of your two books and I could translate it or you could authorize me to translate a part of "Vol sans Battements".

Yet I think it would be better if you would write an article of unpublished facts to rouse the curiosity of people who do not know anything of gliding, and furnish about 6 to 8 illustrations with it, the most startling ones would be the best. They could be either drawings or very distinct photographs. You will then see in the magazine with how much care they are engraved.

In one of my letters I asked you for an address more particular than General Delivery so that no more letters are returned to me. Mr. Langley is of the same opinion so he can mail you the 250 francs. He says that he does not like to take anything away from people which belongs to them, without compensation, even if the law would be on his side if he would not pay for it.

Very truly yours,

O. Chanute

Cairo
October 28, 1892

Mr. O. Chanute, Engineer
Chicago

My dear sir,

Enclosed are the signatures attested by the Consul General of the United States.

I believe that I am about at an end with my correspondence. I hope that my last letter arrived before you left for New York and that you could spare a few moments to give it some attention.

As I have no important work to do I entered the Egyptian Government's Public Works Service which keeps me busy till 2 o'clock in the afternoon. So I have enough time left to go over my book and to think of aviation.

Now it will be your turn to write and I will have nothing to do but to answer your questions.

Some of these days I shall send you by parcel post several small airplanes made of paper. One of them has a gliding angle of less than ten degrees but I am unable to send it to you because it is too big for the regulation size package. But there is a smaller one or several smaller ones which I shall send you.

So, goodbye, for the present, dear Sir. I do not want to send off these two papers without having the pleasure to give you a handshake.

I am as ever

Your very devoted

Mouillard

Cairo

November 18, 1892

Mr. O. Chanute, Engineer

My dear Sir,

I herewith confirm my last letter in which the two papers, signed and attested to, were enclosed.

For safety's sake you may add to my adress: Rue de l'Eglise Catholique (Catholic Church Street).

At this point allow me to ask you to express my thanks to Mr. Langley for the generosity and kindness he wants to show toward me.

I also ask you to tell the editor of the Cosmopolitan that I am preparing the article on gliding of which he spoke to you, as well as some drawings of birds in flight,

Unfortunately photography is out of reach for me, as a very strong landscape lens would be necessary in order to show the vultures in any other than a microscopic picture. I simply cannot afford it, which is too bad because I have some models all ready to pose. As for snapping their picture in full flight, I have been dreaming of a camera that would hunt for them way up at 300 meters, but I can't even think of doing that.

Photography would certainly be an infinitely more exact evidence than a drawing, but for want of a camera one must resort to a pencil.

In your letter prior to the last one you told me that while you are in New York you would find out more about the boat; in your last letter you do not mention it at all; please, what has happened?

I also wanted to ask you when you could return my book so that I could make use of your kind offer to advance some funds toward its publications. I have my notes but not a duplicate of the manuscript; if I had to rewrite it, I would be quite embarrassed, as I have actually not much time at my disposal.

Please accept a cordial handshake from

Your devoted

Mouillard

December 12, 1892

My dear Mr. Mouillard

I received your letter of Nov. 18th just when I was about to write you.

But first, I beg your pardon for not having acknowledged receipt of your letter of Oct. 28 with the two signed papers. However, I had been buried under an avalanche of work, and then I have to inform you of the death of Mr. Hastings, the young engineer whom I mentioned to you at the time when I hired him to translate your book and to make experiments later on.

He passed away recently after a lingering sickness which incapacitated him for one year, and only half of your book is translated. I am going to send you this half at once, and I wrote to Professor Langley to send me the chapters which are in his possession. When he learned that you had applied for a patent he consented to see the chapters referring to the airplane which he had refused to do previously. Within a few days the package will leave here by registered mail.

In regard to the other half I do not know whether it would be better to try and translate it, despite my other work, or whether it would be better to send you the entire manuscript and make the translation from the printed pages. I confess that this book means a great responsibility to me and I shall feel more at ease to know it is in your possession. I have kept it in my strongbox with orders to my entire family to send it to you at once in case I should die suddenly. However, I also cherished the hope to hand it to you personally.

For I entertained the idea to pay you a visit this winter in Cairo when we could discuss some observations and questions which you never answered. (I do not say this to reproach you in any way for there must be a reason for it on your part.) However, my wife is afraid of an ocean trip and as she is in poor health I do not dare to leave her alone. Besides I shall have to battle here this winter with the patent office.

Quite recently this patent office refused to grant you a patent; it says:

"Examining the project presented we believe that the described invention as a whole is not practical, since the machine cannot rise without a balloon. In other words the project is not useful according to the meaning of the law. No evidence will be considered sufficient to demonstrate the efficiency of the project and to cause the patent office to rescind its objection, unless it is a model in full operation which would be capable to make an ascent and to be controlled."

In a conversation with Mr. Whittlesey the examiner said some affidavits could be considered which state that experiments have been made with the invention if the facts were well specified; but even so a small model would be necessary to demonstrate the theory of the invention. Mr. Whittlesey wants to know whether you could supply these requirements. The sooner the better.

I do not need to tell you that this decision is absurd, but it has been made by the authority and must be appealed.

I have already made arrangements in this direction. In my article next month I shall speak about you and I shall go to Washington and take the matter up personally with the examiner in charge. You, on your part, please send me all the data you may have.

You know that in this country the patent office judges the usefulness and the novelty of an invention before granting a patent, while in Europe most governments issue patents to anybody who applies for, and let the inventors clear themselves when involved in a law suit. For this reason it is always better to take out the first patent in the United States.

I was told in Washington that the patent office had been swamped lately with plans for air navigation, every one of them as absurd as the other. This perhaps is the reason for the new severity with which the office acted against you, because it has passed upon very queer cases. If worse comes to worst, please let me know:

- 1) What do you think would be the cost of a complete airplane?
- 2) When experimenting in the open, would it be possible to disguise the construction sufficiently so that the idea would not be understood and the machine could be flown before the patent is issued?

In reference to your boat, I presented the proposition briefly to Mr. Mosher, the famous designer of high-speed yachts in New York. He was not enthusiastic about it. He said that perhaps it is possible, but hardly practical. However, he consented to examine the matter more seriously. But he does not read French so I shall have to translate the entire description into English and I have not yet found time to do so. I expect to make him acquainted with all your maritime inventions, except the torpedo, on which subject I shall write you a separate letter so there will be no mix-up among the various matters.

I wish you a very happy New Year and am with a sincere handshake.

Very truly yours,

O. Chanute

December 22, 1892

Mr. L. P. Mouillard

Dear Sir,

I just received the chapters of your book which I gave to Mr. Langley, but I notice that one part of the translation which Mr. Hastings made has not been corrected, so I shall do it at once. This will cause a delay of three days, and today I wish to take matters up with you about your torpedo. I have read your letter over and over again and pondered over it very seriously. The idea is new, ingenious, daring, it may be successful and the results are incalculable. But alas, my dear friend, like most of the inventions you have sent me, it is very hard to cash in on it within a short time, and if I understand it correctly that is just what you want to do, so that you could use the proceeds to realize your airplane.

There is only one interested party and that is the government, and ours is not in the least prospective. The men in charge may therefore take plenty of time to wrangle with the matter and perhaps will not have anything to do with it. However, I am sending your study to Mr. Langley, asking him to keep it confidential and to give us his opinion.

I told you different times that the airplane was your great asset and if it should succeed your other inventions would be more easily accepted. For several months I have thought about different ways to make your success easier and I hesitate among different ways.

You have asked me many a time to make experiments according to the directions you sent me. I have not made any, because in case they should not turn out successfully you may think this is due to lack of care and intelligence and this would cause disagreement between us. On the other hand if I send you money to enable you to experiment yourself before the patents are obtained, the invention may be stolen.

There is still another way which would be to ask you to come to America to conduct experiments, but I am not a rich man. I could set aside 25,000 francs for the experiment but if it should not meet with success I had to stop right there. What would then become of you? I would have uprooted you from your house, and I never could forgive myself.

To be able to judge the probability of success is the reason why I intended to pay you a visit in Egypt, why I asked you so many questions about "suction" and why I am impatiently expecting the airplane model you intend to send me. We have in this country a Mr. Lancaster who claims to have produced "suction". However he hides from everybody and has taken refuge in a desert in order to carry out experiments.

I believe you are better prepared than anybody else to succeed in gliding flight but this may take much more time and may be more difficult than you think it is. And then, after all, the wind in the temperate zone is not always blowing at a favorable velocity and the practical application may be limited to countries where soaring birds have their habitat.

Write me very frankly your opinion about all this.

I wish you a happy New Year and remain sincerely

Your friend

O. Chanute

111(a)

Cairo
December 24, 1892

Mr. O. Chanute

This letter simply wants to make you remember me and to wish you a happy new year.

I am preparing the article for the Cosmopolitan. I only have the drawings to make. It takes long for I have little time to give to it.

I don't dare tell you that I am disturbed because I don't get any letters from you, but that is the case. But the proverb says: No news, good news, and I have faith in it.

Be in good health, dear sir; I wish for you and yours a year as you wish for

Affectionately

Mouillard

December 25, 1892

Mr. L. P. Mouillard

Dear Sir,

I am sending you by registered mail all parts of your book which have been translated:

Envelope No. 1		Introduction
		Preface
Envelope No. 2	Aviation	Up currents
	"	Flapping wing flight
	"	Flight without flapping wings
Envelope No. 3	"	On penetration
" " 4	"	Suction
" " 5	"	Horizontal control
" " 6	"	Vertical controls surface
" " 7	"	Fixed airplane
" " 8	"	Experimental airplane
" " 9	"	Engine powered airplane

This is the important part of your book. As the pages were not numbered when I received them, I numbered them with pencil on the bottom of each page; this has been done a second time for one part of the book which arrived later than the other.

I think that when you review the book after the fire of the composition has cooled down, you will make some transpositions and changes in addition to those which you have already pointed out to me, before giving the book to the printer. Do not be embarrassed by doing so, for I know that I have to revise my translation by comparing it with the printed book, before giving it to the publisher here. Furthermore, unless the English publication comprises "L'Empire de l'Air" and "Vol sans Battements" in one volume, several passages of the second book have to be changed so that they may be understood by those who have not read the first one.

In one of my letters I believe I have informed you of my opinion on the subject of the chapter on "suction" which should be written with as much emphasis as possible as it is bound to captivate the attention of the readers.

The part which is still in my possession consists of:

Envelope No. 10	Bird studies	Picture-Studies
" " 11	" "	Liometis Nasicus etc.
" " 12	Kite	Kites-Sail
" " 13	Balloons	Alpine-valve, Atmosphere
" " 14	Parachute	
" " 15	Chats	
" " 16	The Desert	

I shall try to translate it by dictating each part. to a stenographer, but I am ready to return everything to you as soon as you ask for it.

You never informed me whether the conditions I proposed to you for the publication of your book are satisfactory to you. My idea has been to put you in a position to realize the possible profits of the sale. However, if you prefer that I take all the risk, I am ready to do so.

With a sincere handshake I am

O. Chanute

Cairo
January 9, 1893

Mr. O. Chanute, Engineer
Chicago.

My dear Sir,

I am deeply grieved by the death of Mr. Hastings. Although I did not have the pleasure to know him personally, I was interested in him as the one whom I hoped may bring my idea to a realization. Notwithstanding his youth he had to die before me.

I shall always remember him.

From Mr. Langley I received a charming letter and 500 francs with which he favored me. I am going to write him by the same mail, to thank him for his kindness.

As to the book, dear Sir, do what you think should be done. I am moved by the precautions that you take for it. I believe, as you said in a former letter, that it will be of interest to me to read it again for, although I have the notes from which I wrote it, I ordered myself not to keep on rereading it, and I have kept my word. It will be nearly new to me now and the faults will be more obvious than if I had read it again and again.

I came to a part of your letter which made my heart beat for a moment. I read it rapidly and was under the impression that you were coming. I had to read it over again to convince myself that I have been wrong and that you are not coming to Cairo. At least I have been happy for a moment! How I would have liked to see you! But I understand and have to yield. You are lucky to be able to take care of your wife. I have lost mine and am afraid for others only to think of it.

If I may be permitted I kindly ask you to give Mrs. Chanute the best wishes for her health and happiness submitted by a humble aviator.

Let us get to the question of the airplane patent. I admit that I never expected such a decision of the patent office. I think that without being wicked, one may say that they have not studied the aviation problem sufficiently. On the one hand the Institute, Mr. Langley, and you yourself and even nature, on the other hand "without a balloon the machine cannot rise", it does not make any sense. The patent office wants obvious, simple, comprehensible and even demonstrated facts. If the facts were practically demonstrated that would be all that is necessary; the demonstration would be rather important and rather obvious to give the entire matter an absolute certainty of propriety.

In view of these annoying facts I recall the ideas I had at the time I was able to act when I expected nothing but the possibility to be able to study. I intended to make my tests upon a small building being at my ease during all the time of my studies and to return to the ground only by airplane to proclaim and demonstrate that I have succeeded. The building, though small, never was at my disposal, spare time never came, as I always had to think of making a living, crawling on the ground. So I decided to present what I knew to other people. Although I have tried to make myself understood as clearly as possible, I am conscious of the fact that I have rallied but a few searchers to my way of thinking. Although I thought to make more believers than I really have had at that time, I think today will be a much better time to succeed.

I am going to answer your two questions:

1) How much will an airplane cost?

The one I have described to you will obviously not cost more than the price of the aluminum and of the spring- several hundred francs, plus the most important of all: freedom of action.

2) For an open-air demonstration, would it be possible to disguise enough of the construction, so that the idea will not be understood?

Before the publication of "L'Empire de l'Air " I have been thinking seriously to try out this airplane, i.e., learn how to fly. As I certainly would have been noticed, I intended to mislead those who might see me, by putting side by side with my back a very light booby propeller which has a diameter of about one meter and would be rotated by the air stream. On the frame of each wing, within the reach of the hands. I wanted to fix two light boxes which however would appear to be heavy, to represent two boilers in which from time to time I wanted to burn some substances which produce plenty of smoke. Seen from a distance this would produce an effect as if two boilers seemed to actuate a propeller.

At that time I hoped and I believe it is still the case today, that due to the prevailing ideas, this simple trick should be sufficient to throw the inquisitive ones off the track; in short, this would be to cash in on the generally admitted idea that an airplane absolutely needs propulsion in order to keep afloat.

As to the question which the examiner asked Mr. Whittlesey the only answer I can give is what you know from my books. In practice I have only covered 42 meters and this without a single witness; but it is not worth talking about. I am like Moses facing the promised land; I see it, my teachers, the birds tell me to enter it and I cannot do it. I cannot think of taking this step myself, my infirmity would endanger the success of the experiments. But somebody else who is more agile could follow the way shown in my books, and reach the goal, with very little effort. As to asking for a model which is able to take-off, would be asking for an airplane handled by a human master who knows how to fly. This is exactly what we want to do by taking guarantees to safeguard our methods by means of patents.

With great impatience I am expecting your opinion on my torpedos. I hope that will be a protection for the ship which has been built to carry them.

Very dear sir, with an affectionate handshake I am,

Your devoted, Mouillard

January 21, 1893

Mr. L. P. Mouillard

Dear Sir,

I received your letter of December 24th. You are about to receive my letters of December 12th, 22nd, and 25th also the part of your book which I sent by registered mail on December 27th. I have translated a part of what I still hold, but by doing so I have overworked myself somewhat and had to take a rest.

To make matters worse, it happened that Mr. Langley had about one third of "L'Empire de l'Air" translated for the purpose of citations. But he is not satisfied with this translation (and I do not blame him) and has sent it to me for revision.

All this is to tell you that your name is the topic of the day here and that I herewith return your good wishes for the New Year.

I hope that we will arrive at a combination which will enable us to put gliding to the test.

With a handshake, I am

O. Chanute

Cairo

January 22, 1893

Mr. O. Chanute, Engineer
Chicago

My dear Sir,

I received my book. I started to read it and it seems almost new to me. I found some annotations in your own handwriting. They are very sound and I am adding mine to them, so that there will be much to be done then.

I am now going to answer your two kind letters.

The way you appraise my torpedoes gives me great pleasure. What does Mr. Langley think of them? I am very anxious to know it. I would be extremely happy to reach a state where I would no longer be restrained, where I would have a bit of freedom, in other words when I would be able to devote myself comfortable and composed to experiments with the airplane. I think it is prudent to admit that this cannot be done in one day, as much as I am convinced of the success. First of all it depends on the subjects we will have for experimentation, then we have to do it over and over again to bring it to perfection. All this takes time and I would like, and this is very natural, not to be under obligation to anybody, not even to you, dear sir, notwithstanding the unlimited kindness which you have shown toward me. I thank you from the bottom of my heart for the money you are putting at my disposal but I want to apply it to aviation only and none of it for my living expenses. My idle fancy is to be in a position by means of my ship or the torpedo to be able to experiment without remorse, without having to think that I live on the bread of somebody else. I hope you will see my point, dear Sir, as I really would like to have nothing better and it seems to me to be common sense, therefore, having presented these ideas, I assure you that I would feel easier if an offer were made.

All this is very well, but as you say, this may take as long as the experimental studies of aviation, and according to the proverb "time is money", I probably will have no choice. Here then is what I think ought to be done.

As I am entirely on the side lines and as you are at the controls, you can observe more clearly and intimately. Please tell me then what I should do. I shall depend entirely on your kindness without restriction, without hidden motive. Decide what I should do, and I shall obey.

I could leave Egypt for some time or for ever. What ties me here is a small herbalist's shop which I run in partnership, with a woman in whom I have full confidence; there is nothing else. I also have a position with the Egyptian government which brings me 260 francs per month, just enough to keep me alive and that is all. No wife, no child, I am entirely free. Above all I dread the summer heat in this climate and shall see America with pleasure. Now it is up to you to make a decision and I shall do what you tell me to do.

Now permit me a word of explanation of what you remarked at the end of your letter. The reason that there are more birds in Egypt than in the Western World is that the people are more kind toward them than the white men. The Egyptians as well as the peoples of the entire orient show consideration for animals and for this reason mongooses, foxes, jackals, hyenas, etc. multiply, and birds are so plentiful. It is the kindness or indifference which is greater here than elsewhere and not the activity of the wind. On the contrary, I am convinced that it is less violent than in the temperature zone. There should then be plenty of wind throughout, to make gliding possible and it would be easy to make use of proper air currents by using a balloon to gain altitude.

I now come to your second letter. I received the book which arrived in good condition and in the perfect order you arranged it. I intend to rewrite the final part of "Suction" as it is colorless and does not please me at all.

As to the question of how to proceed with the publication of my book, I did not answer for the simple reason that I did not dare to dwell upon this subject. You are giving everything, why start a discussion? Here again I shall follow your lead.

If I had not written my two books which should show a very free will when it was necessary, I ought to seem to you to be an irresolute person; but fortunately for me this is not so. I have made up my mind how it should be done. Yet when you heap favors upon me, I confess there is nothing left for me to do than to let you decide in these matters.

The first book required a large advance payment on my part. I do not know exactly what became of it when the account was balanced; it seems to me it should show 700 or 800 francs in my favor. At any rate the publisher owes me and I owe him nothing. I hope that the "Vol sans Battement" will sell at least as well or even better than "L'Empire de l'Air" even if the price is twice as much. There will probably be a much easier sale of this book from the start, as the reader will get more value out of it (generally speaking). In short, it should have more success than its predecessor which had to pave the way. Finally the income will be doubled. Here you have a statement of what I think of my book. Now, if you please, be kind enough to handle the problem.

I just read my letter over again and find out once more that I lack power of decision. I want you to blame it on my embarrassment due to your generosity.

With an affectionate handshake, I am

Your devoted

Mouillard

February 17, 1893

My dear Mr. Mouillard,

About 10 days ago I received your kind letter of January 9th but I was so overworked that I could not reply. Today your letter of the 22nd reached me.

My wife was very much affected by your good wishes. However, she has been suffering very much and the doctor advised her to spend several weeks in the South. We are going to leave for Florida tomorrow evening. I am answering your first letter now and I shall write you again from the South.

I translated the rest of your book except the two chapters: "Chats" and "The Desert", using the dictation method. I am going to make any corrections necessary while on the train and I am going to send you the book from Florida.

Here is an idea which I am considering for quite some time: It has been proposed to hold an Air Navigation Meeting in Chicago on August 1st, 2nd and 3rd of this year and I have accepted the presidency of the organization committee. At the end of this meeting I intend to present a plan whereby I propose myself to be one of 20 persons willing to advance 25,000 francs each to experiment with flying machines which seem to have a chance of success, with the provision that the inventor transfers one half of his patents to the society. What do you think of this plan?

If I should succeed, and if your project is entrusted to this society (of which I am not clear) I shall transfer my half to the society while yours remains intact.

At any rate, I intend to present to this meeting a treatise by you which, by the way, is already completed. It is your proposal for a society of experimenters on the shores of the Mediterranean, which could just as well operate on the Gulf of Mexico or the Pacific Ocean.

All it needs for publications is a short introduction.

1) Explaining that gliding flight is a reality, and what are the maneuvers of gliding birds.

2) When the wind provides the necessary motive force, it seems certain that man could imitate these birds if he knows how to start out.

3) That this takes time and practice.

4) That there is nothing better than freedom of action to learn how to use any kind of flying machine.

5) Followed by your plan of a society of experimenters, either a good copy of the text of the book you are about to publish or re-edited especially for this paper if you so prefer.

All in all from 3000 to 4000 words which I shall translate and have printed before the meeting takes place to serve as a basis for discussion among the participating aviators.

I did send you a program of this meeting already and I am sending you another one, but I am so tired out from other work that I could not translate it for you, as I intended to do.

Mr. Langley wrote me that he has not yet been able to examine your torpedo but that he will do so soon. I believe that he is very busy, like myself, has not much time to spare.

With a handshake, I am

O. Chanute

Address mail to Chicago as usual.

P. S. In order to get a little better informed on the question whether it would be better to have a society entrusted with the experiments of your projects or to carry them out myself, please tell me:

1) Have you got somebody in Egypt to make these experiments under your direction?

2) How much money do you think would be necessary to defray all expenses in order to obtain a certainty as to the results.

3) Have you had any propositions from French aviators? I think that acceptable offers could be made to you since it is known that you have applied (for a patent) in America.

Cairo
February 19, 1893

Mr. O. Chanute, Engineer
Chicago

My dear sir,

Yesterday I forwarded by registered mail a metal tube containing the article for the Cosmopolitan and two drawings - 1) Vultures in flight and 2) an enlarged drawing of some stages of this flight.

I have been unable to send you the small paper airplane models because the post office in Cairo does not accept parcels for the United States. I feel bad about this, as I doubt that they would arrive in good condition otherwise. These models are so delicate and so fugacious that unless they are properly shaped they will not demonstrate what they are able to do. So it will be necessary that somebody who knows how to do it reshapes them after each performance.

Between the pages of my book I found an aluminum paper cutter. As it had been carefully wrapped in paper, I take the liberty to thank you very much for it. At the same time, I want to state that it seems to me that aluminum for aviation should be different than this sample. At my opinion it should be heavier than 2.6. It has not exactly the same color as a piece of aluminum I have in my possession for at least some ten years, and above all it is not as rigid as mine. If I can read between the lines, I should better say guess, Mr. Langley ought to be well acquainted with the metallurgy of this element and its alloys, if you have a chance, will you kindly ask him his opinion about mixtures of silicum and aluminum; I think that this metal is very light and strong.

Lately I have often been thinking of airplanes and I came to the conclusion that the best aviator I can think of is your devoted servant (I say this without self-conceit). On the other hand I could not think to use the machine you patented, unless I was 25 years old once more. Here then is a difficulty to be overcome. It could be done by means of an aircraft I have briefly mentioned - webs actuated by a rotary engine which you have seen on my torpedoes, setting in motion a body and bird wings. This machine should be less troublesome to handle than the patented one. This is what I have in mind at present. I believe that it may be possible to lift several passengers. This must be seriously worked out.

I wish to thank you immensely for the article you wrote about me in the Engineering Journal.

With great anxiety I am waiting for news about my torpedoes.

This is all I have to say today, dear sir. With an affectionate handshake I am

Your devoted

Mouillard

St. James City
So. Florida
March 28, 1893

Mr. L. P. Mouillard

Dear Sir,

Several days ago I received your letter of February 19th and I just received your article for the Cosmopolitan which does you the finest credit and which I am going to translate, as soon as I get back home.

However, I notice that you do not explain in the text the meaning of the enlarged drawings of the individual birds. Would it not be expedient to indicate the action of gliding in reference to the attitudes of the birds which you reproduced? If you agree with me, let me have this indication, either some paragraphs to be inserted in the text (which at my opinion would be preferable) or some subtitles to be added. I shall send you a tracing of your drawings, as soon as I am able to get thin paper, for I am here in a lost hamlet where there are more vultures (aura), pelicans, frigate birds, eagles, and gulls than human inhabitants.

Unfortunately I have been more exhausted than I knew and I could not enjoy these birds as much as I would have done last year. I am recuperating but I did not have the strength to revise my translation of your book. I therefore ask you kindly to wait a little while longer until my mind is clear again.

I am happy to be able to report to you that my wife has recovered her health much quicker than I did, and we are thinking of returning to Chicago soon.

With a handshake I am

O. Chanute

April 2, 1893

Mr. L. P. Mouillard

Dear Sir,

I am sending you some tracings of your drawings "Some individual birds enlarged" on the only tracing paper I could get. As it came in small sheets I had to split your plates into several lines.

As I wrote you, the readers would not understand the relation between these drawings and gliding without being more fully informed. Please return the tracings to me with indications which are needed for printing your article (in a single plate or distributed in the article); some attitudes which you depicted (gliding, turning, taking-off, landing, etc.) also add some paragraphs explaining how the bird utilizes the wind and dispences with flapping the wings by means of these various attitudes.

Very sincerely,

O. Chanute

April 24, 1893

Mr. L. P. Mouillard

Dear Sir,

I returned from Florida, as my health is almost fully restored.

The drugs which I had to take to get this result have weakened me in such a way that I still have been unable to revise my translation of your book. However, I shall do so and send you the package within a few days.

As to the terms of the advance payment for the (printing) costs, I think it would be best to give me an assignment on the book dealer in charge of the sale until the amount loaned has been reimbursed, after which he has to give an account to you. In this case you would not have to sign a note and would be free of the fear of its due date.

Let me know when you will need the money.

I shall write you more fully shortly. I find plenty to do after an absence of two months.

With a handshake I am,

O. Chanute

Cairo
April 25, 1893

Mr. O. Chanute, Engineer
Chicago

My Dear Sir,

Returning from a rather long visit with my friend "the desert" I found your kind letter which I want to answer at once.

I am very glad to learn that Mrs. Chanute is well again, but am quite sorry to know you to be still sick. Allow me, dear sir, to scold you a bit.

It is necessary to beware of any excesses whatever, even excessive work. I look at you from a distance and see that you are working too hard: Exposition, aviation, your wood-preserving factory, many presidencies of which I could catch a glimpse etc., etc., and I know that I do not know the rest of it. Altogether this is too much for one man. You have got to go easy and not to kill yourself. I am convinced that your family thinks the same way; I join them in begging you to rest, to recuperate in peace and to watch the things you have sown grow and prosper.

I wish to beg your pardon for daring to moralize, yet I can assure you it comes from a sincere friend.

I am convinced that this letter will meet you in Chicago fully recovered and exultant, the way you deserve it. This ought to be a good day for those attached to you.

From afar I will witness your triumph the best I can; but I am sure that I will never be able to realize the smallest part of your great success.

April 24. - I received your letter of the 2nd inst. The change of place seems to me to be a good sign, you do not speak of health, so that is plenty of news, good news; no matter, I did not want to recommence my letter.

Here are the titles which I think could be used for the two drawings.

Sketch #1. Flight of fellow vultures (gyps fulvus)
" #2. The above drawing enlarged

1.-2.-3. Aspect of the course of flight. The bird arrives from quite a distance, above the feeding place, after having many kilometers at that speed without the need for a single wing beat.

4. The prey has just been sighted, the bird speeds along in the air, and describes with rapidity enormous circles that enable it to see from various angles whether the dead animal is accessible.

5. It seems that this vulture did not find it safe enough to alight so it climbs back into the air using gliding flight. This bird and the one marked no. 11 are the only subjects in this drawing which are in a climbing position.

6.-7.-8. These three vultures proceed to scrutinize the harmlessness of alighting on the prey - the bird glides in the air, but descends slowly. The angle at which the bird drops is about 10° .

9. This subject shows a free fall. Yet it is also a descent and a forward translation because the wing tips are downward.

10. Vertical dive without forward or backward motion.

I think this is sufficient. Besides, that is all I wanted to say. In order to demonstrate with precision the positions of the wings during flight, a mechanical bird would be necessary whose wings and body could make all the turns a bird makes, so this could be shown from every angle. It is not easy to bring these points out in a drawing.

I just remember that I forgot to sign drawing No. 2 with my anagram. Will you be kind enough to put it there. You will notice it on the bottom of Flight of vultures, it isWill you also be so good, dear sir, to convey to Mrs. Chanute the feelings of my deep satisfaction of her full recovery, and accept a sincere handshake from

Your devoted

Mouillard

Please, how much do you weigh when you are in good health?

May 21, 1893

My dear Mr. Mouillard,

Your kind letter of April 25th reached me in Kansas City, 160 miles from Chicago. Here is exactly one of my many presidencies you have been guessing about.

You are perfectly right when you scold me in a friendly way about the excessive amount of work I am doing. I want to ease this load and this is the reason why I am here. I am trying to sell one of the enterprises in which my small savings are invested. For many years I have here a trucking company which has not yielded anything for the past five years, and, loss for loss, I rather put this amount in aeronautical experiments than in 100 horses and 70 wagons which I own here. You see, I have you in mind.

There is also something else. I am aware that the translation of L'Empire de l'Air which has been made for Mr. Langley does not express your thoughts at all and does not do you justice. I am going to do it all over again and add here and there a phrase for the benefit of the examiner at the patent office who thinks that an airplane cannot take off without a balloon.

As soon as this is finished I am going to translate your article for the Cosmopolitan, and ask your permission to modify certain parts of it, to make them understandable to the readers who are not informed on the subject. Your style is admirable, but from time to time there are some implications which my friends to whom I read the article, translating it aloud, did not understand unless I gave an explanation. I also believe that it would be of advantage to go over the passage which treats the rolling ball.

When I am in good health I weigh from 66 to 68 kilogrammes. At present I weigh 65 kilogrammes but I am regaining the weight lost during my breakdown.

I would be glad, if it would be possible for you to give me some instructions necessary to reconstruct the model airplane which you could not send me by mail. My next letter will be coming to you from Chicago.

Sincerely yours,

O. Chanute

Cairo
May 27, 1893

Mr. O. Chanute, Engineer
Chicago

My dear sir,

I received your last letter in proper time. I thank you once more for the kindness bestowed upon me and I agree perfectly with you about the notes which might put me into embarrassing circumstances and interfere with my studies.

Now this is settled; only at present there is no hurry, because I have formally decided to put into practice myself the ideas which I express in my two books.

A real improvement of my illness urges me to do so. I feel well, am getting strong and active again and I believe this to be the moment to act. This may be my last chance.

Besides, the method I want to try requires the least exertion of all I have put together.

I kindly ask you to consider very seriously the following statement. You are herewith authorized to act as my attorney, sign for me whatever is to be signed, do and act as I myself would do it if I were on the spot and not in Cairo.

I take the liberty to ask you for this service as the two months it takes a letter and the reply to it get to their destination are an obstacle to any transaction.

I therefore ask you to act as my attorney, as you see fit, and I shall consider valid any action you are going to take, and shall back you up to the extreme limit.

Here is the reason which compels me to write you these lines. I certainly do not doubt for a moment your good-will toward me. I am conscious of the fact that you are convinced that I shall not disavow any of your decisions. Therefore these lines are not meant for you but for the outsiders to satisfy them that you have the power to act in my behalf.

I consider then this letter to be a formal power of attorney which I give to you to act for me at your best judgement. As far as I am concerned, I shall do everything which is humanly possible to meet any obligation you may have entered into in my name.

In case you are going to form the society you mentioned to me in your recent letter, I kindly ask you to decide what I shall do, and to tell me only afterwards without having consulted me beforehand, to what you have me obligated.

The same holds good for any other occasion where you consider it to be a good thing to act for me.

Here is such a case: I kindly ask you to decide what I shall do in regard to the prize competition presented by the Smithsonian Institution. Mr. Langley sent me the circular concerning the Hodgkins fund prizes. I discern rather vaguely that this is a competition about matters of the air, but, considering the distance and my ignorance of English, I cannot make out the details and do not perceive the finesses. I cannot determine whether or not it will be expedient to take any steps in this direction. You know these things exactly and I do not know the first word of it.

Finally, this power of attorney has also the purpose to state precisely that I ignore the question of danger which seems to be connected with any flight experiment.

I think very little of this danger. I have discounted it long ago and I think it is hardly greater than those presented by common means of transportation; horseback riding, sea and land travel. The main thing is to take proper precautions to avoid this danger.

Résumé: I am very far away from the place where a transaction is going to take place, in order to be nearer to it, I kindly ask you to substitute for me.

With an affectionate handshake, I am more and more

Your devoted

Mouillard

Yesterday I got a series of stimulations in advance of that program which came to me from the United States, by the chance of seeing a hundred large vultures pass overhead. Not for a long time have I had an opportunity to observe them so well. The effect produced is always the same: Here is the way. The small vultures which are in front of me all the time do not incite the idea to imitate flight, because of their lack of stability and the motions due to this fact. However the large vultures create positively an obsession; it is a revelation.

I thank you very much for the prints on Langley's flying machine. I did not understand a great deal of it.

Your devoted

Mouillard

June 14, 1893

Mr. L. P. Mouillard

My dear sir,

I returned from Washington where there is no use reasoning with the patent examiner. He now says he wants a declaration or formal statement instead of a deposition, and also a model that reproduces the ascent.

As you made your memorable experiment without witnesses, you must make this deposition yourself, have it translated and confirm it under oath before the representative of the United States.

The model may be more difficult, but I think you might be able to send me one which, when exposed to wind, may make the ascent backward so as to explain that animation is necessary to create suction.

Please send me these two things as soon as possible.

The translation of your article is almost completed and I hope it will have quite an effect on the examiner.

The translation of L'Empire de l'Air? (excerpts) for the publication of the Smithsonian Institution is half finished. I had to do it all over again.

In Washington I procured the report on experiments made in Berlin in 1891 and 1892 by Mr. Lilienthal, a German engineer who experimented with a machine to glide with the wind. I am sending you the pictures which Mr. Curtiss of the Smithsonian received from Berlin. I am using these pictures for my next article which I shall send you as soon as it is published, in about two weeks. I am so busy that, to my deep regret at the present time I am unable to translate it for you.

Lilienthal figures on up-wind to get suction. So far, he has not ventured to apply himself entirely, but he made some descending gliding flights. He started out with a machine of 10 square meters but had to reduce it to 8 square meters (less risk). Last year he tried 16 square meters but says this is too dangerous. He also says that it is not necessary to take a chance when the wind velocity is beyond 10 meters per second and that it will be necessary to be able to abandon the machine the moment a gust strikes unexpectedly.

I do not quite understand this machine. Will you please explain it to me? You have not answered my question: "How much do you need to make your experiments in Egypt?"

I sold my trucking business, but had to sacrifice 100,000 francs and accept time payments.

Very truly yours,

O. Chanute

For Lilienthal's book see the January 1892 issue of L'Aeronaute.

Cairo
June 24, 1893

Mr. O. Chanute, Engineer
Chicago

My dear sir,

I confirm my letter of May 27th. I reply to yours of May 21st. I wish to say relative to the small airplanes that you will find a very clear description of them in "Vol sans Battement". I believe you have that part (of the book) as I could not find it among what I have of it. However, I remember the passage clearly to be able to make these small models alright.

However it is hard to describe how to make them operate well. A large number of try-outs will be necessary in which the speed with which these models are launched must be in accordance to the creation of a good equilibrium of the model. As these little airplanes are merely small triflings, they require plenty of thinking and corrections, in order to make them fly well.

Therefore refer to the chapter mentioned above, build according to the directions, experiment and do not get discouraged if everything does not turn out well the first time. This is the beginning of the flyer's profession to be learned, a profession which at my opinion is too much neglected.

To prove this, let us say that one of these little models operates well in three flights while I handle it, yet somebody else may not succeed to bring the same model to a glide for hours.

In order to have these little toys well controlled, you have to satisfy yourself that the load is in front. It goes without saying that weight and surface must be in good proportion, that the two wings must have equal surfaces, and above all the same curvature, which is an essential point. If, after this has been done, the fall is too fast, make the correction either by increasing the action of the correction fold, or, if it is an airplane with displaceable wings, by moving the wings forward. By the same token reverse the procedure in case the airplane wriggles too much which means makes many dips. For this case read the page again which treats this subject in "l'Empire de l'Air."

As I suggest, see that you bring the launching throw into exact agreement with the speed, neither too fast nor too slow. The speed which the hand imparts to the model must be exactly the same which it will have in its travel when it flies alone under the effect of attraction.

The purpose of launching by hand is to save space which is precious indoors. The other method of launching is the plain drop without any outside push. This might be called putting a mathematic start of action. The airplane is taken with two fingers by the tail, nose downward absolutely perpendicular. When released it will right itself during the fall until it

reaches a horizontal position which it ought to maintain. This change of position from vertical to horizontal less 5 to 10 degrees should progress not too rapidly which would be too easy to produce, nor too slowly as the height required for the drop would be too great. The arc which answers my purpose is a quarter of a circle which has a diameter of about 2.50 to 3 meters. The airplane is then released from this height above the ground, turns around before reaching the ground and races above the ground horizontally.

This launching method is much more difficult than that by hand. In any case, dear sir, especially in the beginning, plenty of patience is necessary. In order to make the experiment less tiresome and not to lose the thread of one's observations and thoughts there should be an assistant who picks up and brings back the model.

I read the description of Mr. Langley's machine in the Aeronaute. It is a translation of the magazine article you have been so kind to send me. I confess (between me and you) I did not quite understand it. After all it may probably be poorly done. At any rate, according to what I saw it is a line of ideas which I have not studied.

Yet there is one thing which amazes me, namely the inability to guess how the control of this machine is accomplished.

This subject of control becomes more and more a matter of consternation. Needless to say I am seriously considering many possible cases that may arise once the machine is in the air. What moves I have to make to see them! I usually find the answer by reasoning and check it later by observing the motions of the birds. I have only to look out the window and see my neighbors, the small vultures.

It certainly is a great advantage to have these "professors" at one's disposal. I rarely see aviators start off with such a study and I ask myself how they are going to handle a flying machine, even a letter-perfect one. It seems to me they will experience the same sensation as that produced by a pair of skates on the feet of somebody who has never practiced on ice.

The airplane of the indolents looks good, at least theoretically.

What else can I tell you, dear sir; here I am in a bird cage and care little what goes on beyond. I am corresponding only with you and with my family. Furthermore, I am unable to explain what whim possessed Madame Adam's "Nouvelle Revue" to talk about me, according to what I have been told, as I have not yet been able to read this article (May 15th). Gliding decidedly must have some real virtues to provoke common people, without any education, in such a way.

With an affectionate handshake, dear sir, I am

Your devoted

Mouillard

Please, what has become of my torpedoes?

July 21, 1893

Mr. O. Chanute, Engineer
Chicago

My dear sir,

This is in answer to your letter of June 14th. The patent examiner asks for something which is very hard to comply with; it is not the formal statement before the authority in reference to the experiment which I am sorry to have referred to in "Vol sans Battement" although it is only incidentally. I never dared to mention this experiment in "L'Empire de l'Air" because nobody witnessed it and even to narrate it under oath has no value as you may lie to a Consul the same as to anybody else; this does not amount to anything. The proof of whether I tell the truth or am a liar cannot be established by this act which at my opinion is of no importance whatever. No, the difficulty lies somewhere else, i.e., in the perfection of an automatic device which produces the two motions which make gliding possible.

For the moment, there is no use to think about it. I have pondered hard over it, but this is so long ago and in such a base that I might as well say nothing about this device. It simply is to call for the practical demonstration of the problem which the aviators are looking for. If we had only this small model, a larger one could easily be manufactured. But for the present time and for a long time to come it is to be presumed that automatic flight has to be dispensed with and that our thoughts should be concentrated on balanced and animated flight. Yes, you said correctly "animation is necessary to overcome the thousand difficulties which this problem presents", and it would be extremely easier to go over a course by means of an aerial or land bicycle than do it by means of an automat. Therefore, let us forget these exigencies which are beyond our reach and turn to the examiner and his patents. Let us create the fact-flight and let us not break our heads on how to agree with all the nonsense of an incompetent examiner.

If you may remember, this was my viewpoint expressed in my first letters; I still stick to it and emphatically so. My idea is to create, and later, according to circumstances, take remunerative precautions, if this is possible; at any rate to create. If the success should only be rewarded by glory, by vain hope if you wish, it would be so intense that I think not much would be left to be desired.

Besides, I am not the one who is opposed to take precautionary steps, but it is the patent office which refuses to allow them.

I thank you immensely for all the worries and work you put into the translations.

Let us get to Lilienthal.

I read again the résumé of his book in the Aeronaute to which you called my attention.

I see that he puts a very great faith in this convexity of the wing. He is right, since this curvature produces a slight forward motion by means of the decomposition of the force (parallelogram of forces) due to the pressure imparted by the beat of the wing.

But this is not sufficient to produce a general forward motion and besides there is another actuating matter in flapping-wing flight; namely, the direction given to the motion. In short, these two pictures surprised me. I spent quite some time looking at them, even with a magnifying glass, but did not understand them.

The one in flight, I say this bluntly, looks to me like a mystification. The more I study it, the more baffled I am. In certain parts the instantaneousness has been absolute, look at the cords (ribs) of the vertical tail, they are perfect. The wings have moved so it is natural that their picture is blurred. But how is it that the rear part came out so sharp and the front so faint? Up to this point everything would still be all right, but no more if the aviator is analyzed. He seems to be behind the right wing down to his knees and to be seen back of a transparent screen. *Résumé*: I do not understand the least of it, or to express myself better, I believe that we are being fooled.

The picture of the machine at rest is more important, but there are many things I do not understand. How are the wings attached to the body? I do not see it. It is impossible that in the small illustration Lillienthal is in a flight position; he rather seems to be placed in his machine without attaching himself to it, simply to appear in the picture with the machine.

I had the note of Mr. Curtis translated. According to this translation I got the impression of falls that are more or less forward against a slight wind (besides he himself specifies it so) but not of a free fall. In this latter way the initial trials have to be made. He seems to have been caught several times in an air current, and does not conceal his fright. He did well, he is frank about it, because it really is terrifying. Only he has been so careful that he has not been carried away as Biot for example, with the machine I recommended to de Massia, or as the writer of this letter with his machine No. 3. It seems to me that the described experiments are nothing but parachute test by means of an airplane, because I do not believe in the veracity of the picture showing the machine in flight.

As it seems that you have no other copies of them, I am returning both pictures to you; the third one does not count. I am adding a picture of de Massia's airplane, damaged by Biot with which Biot revealed a clumsy flight over dry ground where you are apt to break your arms and legs twenty times and your head to boot. I reprimanded him severely and advised him to make use of a river or lake as a landing place. However, he replied that he cannot swim and that he is very much afraid of water. There must be plenty of truth in what he wrote me, for he discontinued his experiments.

Finally, what the translation which I have read describes is not flight at all, but testing the force of the air, with much caution at that. My 42 meters were the start of broaching the matter, only it should have been done at once with a controllable machine such as the one you endeavor to get patented. Such a machine would first of all be stopped at will; then, by moving the wing tips gradually forward, the flight could have been continued a little bit longer even if there was a regular absence of wind. If during the moving of the wing tips a new air current would be encountered the flight could be taken up anew, simply by releasing the hold of your hand. This may be kept up for quite a distance. However, my airplane No. 3 was rather a parachute than a controllable machine, a fact which chiefly caused me to be afraid.

If you study Lilienthal's airplane carefully I do not believe that you are able to understand how it is attached to the body of the aviator and how to create the variations of vertical control. As for horizontal control there are the two tails which should be sufficient for free-fall experiments, but they would be not enough for a glide of only 10 meters per second.

Here you have plenty of words; it seems that I talk much and act very little. I had better start to produce instead of talking.

By the way, this is a good moment to answer the question you asked me in one of your recent letters: "what amount of money would be necessary to make experiments in Egypt."

Here is my idea. You told me of the happy recovery of Mrs. Chanute. Please persuade her to spend several months of the winter in Egypt with you. I can assure you that this would not be disagreeable whatever. No rain, ten degrees above zero, dry air, and radiant sunshine.

At the same time you could form an opinion of "the friend of the birds", for it is of elementary discretion to know by sight people with whom you have connections. You may see for yourself what is to be done to do a good job, whether the conditions around me answer the purpose or whether I would do better to go somewhere else. Egypt would be satisfactory for experimentation but deplorable for construction. There is a possibility that I am exaggerating, so you will be able to consider this case better than I.

At that time I shall have completed in its details the airplane for inactive people which I shall explain to you and you will know what to think about it. At the same time we could discuss the problem and accomplish more in one afternoon than in years of correspondence.

I also shall show you gliding flight at close range without disturbing you in the least, simply from the top of my roof. My small vultures will be there and will give as many lessons as will be necessary to understand it. I even promise to show you some large vultures and I expect to transform the theoretical friend of aviation which you are, into a fanatic of practical gliding.

Therefore, do not tire yourself out with the exposition. Some of these days you have to preside over the Congress. Be firm in your discussions, but you will agree with me that all the excellent oratory there will not have as much value as a short flight of a hundred kilometers.

It is really my ambition to accomplish that flight and I do not believe that this is very difficult.

Hoping to see you at the beginning of winter, I am with a cordial handshake

Your very devoted

Mouillard

Could you get me a sample of the steel and aluminum alloy in sheet form about 3 mm. thick. I read that Mr. Langley has used this material in the construction of his aircraft, and I would like to take a look at this metal to form an opinion about its strength.

August 13, 1893

Mr. L. P. Mouillard
Dear sir,

You must be surprised at not having received any reply to your kind letters of June 24th and May 27th but the reason is that I have been overburdened with work. Besides the translations of "L'Empire de l'Air" and of your article as well as the preparations for the Aeronautical Congress, the entire Congress of the Engineers has been dropped into my lap due to illness of the colleague who had charge of it.

At last, I got through with and can breathe a little easier to give you some news. First of all you made a hit with the Aeronautical Congress. As you did not send me the note I asked for on Feb. 17 on your experimentation project, I extracted this paper from your book and presented it to the meeting in your name. It turned out that the idea of a school for gliding experiments has been budding in several hands and there were four proposals for such experimental programs. Everybody admitted that your plan is the best.

As soon as I completed the translation of your article I sent it to the Cosmopolitan on June 26. Not a word since! As a rule an article is paid for when it is printed, and I suppose the publisher waits until such a time. However, I wrote him to learn when the article is going to be published.

It is therefore my opinion that you are about to make a fine reputation in the United States. The above article, the translation of "L'Empire de l'Air" which the Smithsonian is going to publish, and the paper presented to the Congress are bound to bring you many admirers and will make possible the founding of a society for making experiments.

You ask me whether it would be worth while to make an attempt for the Hodgkins prize. I do not know anything about it. When I spoke about it to Mr. Langley, a year or so ago, I understood that Mr. Hodgkin's idea was for the promotion of the study of the nature and properties of atmospheric air as a question of hygiene and was not at all meant to encourage air navigation. I wrote him on that subject.

Mr. Langley returned to me your torpedo at last, but his opinion is not favorable. He says "I regret not to be able to believe that this idea is practical. I am hard pressed for time at present, and cannot go into a lengthy explanation of my reasons."

I am going to check the translation of the rest of your book before I send the manuscript to you. Since my illness last winter, I have not had a single day of leisure but I hope to get some since the Congress is concluded. Yet I can tell you forthwith that the description of the small airplane is in the part (of the manuscript) which is in your possession.

There is a passage in your letter of May 27th which I do not understand. You say: "I thank you once more for the kindness bestowed upon me and agree perfectly with you about the notes which might put me into embarrassing circumstances and interfere with my studies."

If this is meant to be a sarcasm or an indirect reproach, I think it is ungrateful. Please give me a frank explanation.

With a sincere handshake I am

O. Chanute

Cairo
Sept. 10, 1893

Mr. O. Chanute, Engineer
Chicago

My dear sir,

I must have expressed myself very poorly in my letter of May 27th so that you could make out such a heinousness on my part as a sarcasm, a reproach. Ah! Please, dear sir, no! there is not the slightest trace of it. I wanted to make you understand, in a discrete manner, that I am not quite certain what amount of money the book will bring, and that it would be better, for my peace of mind, that you take over the direction of the good work that you wish to do, than to leave this job to me. I am not rich and these notes are a terror to me. Can you figure in what straits I would find myself if I could not pay my debts? Only to think of it, turns my hair grey. Now you will understand that the musings of the "kind dreamer", as I am called, would be entirely disturbed. That's what I wanted to tell you and nothing else. Then, dear sir, excuse what I am going to say, I do not understand what in my letters could make you suppose that I might be wicked occasionally.

The more I think of it the more I feel the necessity of getting better acquainted. If I could go to Chicago I would call on you, but I am unable to do so. You, who have freedom of decision, please take this step. I beseeched you in my last letter to do so and I reiterate this request today, so that once you know your man, you would never again entertain such a supposition.

At the same time I would have the opportunity to thank you by word of mouth for the kindness you have shown, not only by guiding me, but also by pushing me forward, by causing me to create, by presenting excerpts of my book to the Aeronautical Congress in Chicago. The pen is not emotional enough to express properly such thanks. For this reason, once more, you ought to come, you ought to persuade Mrs. Chanute to make this trip. Besides, this is no great matter for travellers like you who take a trip from San Francisco to Florida. From Paris to Cairo is a little matter of 14 hours by express to get to Marseille, then one hundred short hours on the Mediterranean Sea and you are in Alexandria. From there to Cairo is 3 hours and a half by express and I shall have the pleasure to shake hands with you to show you the city of the caliphs, the pyramids, etc., etc., and the master flyers, the small and large vultures. Please tell Mrs. Chanute that there is no possibility for her to get tired out. There are thousands of carriages in Cairo and splendid hotels. Naturally I would see to it that you are not being annoyed, as foreigners usually are, by the Arabs. In other words, I shall do my utmost to make your stay in Egypt an agreeable one.

What a job you must have had this summer! About the Engineering I cannot say anything, but yet I can understand that it could not bring itself into being all by itself. As to the Aeronautical Congress, I hope you are going to send me a report which would enable me to take notice in every detail, of all the good things you had the kindness to say about gliding.

I thank you for the information on the Hodgkin's contest. I saw too late that it was not in my line. Also thanks for the trouble you underwent to translate the "L'Empire de l'Air", "Vols sans Battement", and the article for the Cosmopolitan, in fact for everything you have done for me.

I am sorry about Mr. Langley's opinion of my torpedoes. Right or wrong, I consider them to be of importance. I can only imagine that pre-occupation and excess of work have prevented him from studying the matter properly. Will you please keep them in secret.

From what you point out in one of your letters, I understand that the boat and the torpedoes should receive a helping push for any success whatever, which would put my name in evidence. The only field where I may seriously expect this is in aviation. I therefore, shall devote all my efforts to my latest airplane.

Thanking you once more for your kindness, I am with an affectionate handshake,

Your very devoted

Mouillard

September 25, 1893

Mr. L. P. Mouillard

Dear Sir:

I received from the Cosmopolitan magazine the money for your article. Instead of \$60 promised they sent me \$100 which I remit, converted into 515 francs, by draft. I shall send you several copies as soon as the article is published.

The day after I mailed my letter of Aug. 13 I received yours of July 21 and waited from day to day for the money from the Cosmopolitan so I could mail it with my reply. I also wanted the financial crisis to pass which hit the United States.

I am happy to know that your health is so much improved and that you have decided to make experiments with your machine by yourself. I would like very much to pay you a visit in Cairo but due to the events I cannot even think of doing so this winter.

We had a terrible financial crisis in this country due to a monetary depression. A large part of my savings was invested in a silver mine which lost 580,000 francs through the depression, which has decreased my income by 28,000 francs.

On the other hand my partner in the wood-preservation plant is seriously sick of an incurable disease and I cannot absent myself at this time.

It is with deep regret that I have to give in to this necessity because, as you so well put it, "we could make more progress in one afternoon's conversation than in years of correspondence."

Write me therefore what your plans are, where you think it would be best to make the tests, and how much you believe will be necessary for expenses.

In my opinion you are wrong by intending to withdraw the patent application. We have started, had expenses, and we ought to persevere. Therefore send me the affidavit of your experiment with Machine No. 3, and I myself shall make a small demonstration airplane which will take-off for the examiner. Only it will take off backward and cannot be controlled. The examiner simply said that an airplane could not take off without a balloon.

Very truly yours,

O. Chanute

Cairo
October 14, 1893

Mr. O. Chanute, Engineer
Chicago

Dear Sir,

I received your kind letter of September 25 and hasten to acknowledge receipt of your draft of 515 francs. Thank you once more for all the trouble you had to undergo for me. I am anxious to see how the drawings which go with this article turn out when reproduced by means of engraving.

What you told me, dear sir, about the money question makes me feel very sorry for you. This depression was no surprise to me. From this distance I saw the storm coming and I felt very uneasy about you. I want to tell you that I feared the losses to be much larger than what you state. Even so, any loss is very painful; yet you must take it philosophically as there is no remedy.

One of the very unfortunate effects of this depression is my being deprived of the pleasure to see you. How provoking this is! Because we need so much time to get together in order to discuss matters, several days of conversation would, I believe, be very useful to the problem we both cherish.

You ask me about the plans of my two new airplanes. As the reply to this question would be rather long, I am going to write a summary of what they will be, and send it to you as soon as I have it completed. You then may be able to estimate the costs yourself and to decide where the experiments should take place; at the same time you will see whether there is need for a patent.

You ask me again for the affidavit of my experiment at Mitidja. This would just provide a morning's discussion so that I could induce you to look at the matter as I do. Because we do not agree at all on this point of aviation which could be called "On the possibility to reproduce gliding flight with small airplanes." You also wrote me that you wanted to make a small airplane which would take off backwards. I do not believe that you will succeed.

I never thought to use small-scale planes because plenty of difficulties will be caused by the smallness of the mass. I said many times that "the bird has the more facility to glide the larger it is". This is an absolute truth which is demonstrated to us by nature and beyond which there is no chance of success. Gliders must be large or they will not perform; the scale of the soaring birds in my pictures demonstrates this in an irrefutable manner.

As you will see I take up this problem (for the very good reason of inactivity) but I am equipped with a mass of 600 kilogrammes.

What you want to replace is the string of the kite. In the animated airplane (the bird) this string is the energy and its effects. By means of a large machine I try to replace the energy partially, but theoretically I do not succeed in doing so completely, even equipped with all the facilities this enormous mass makes possible.

Getting back to the affidavit of my gliding flight. It happened by taking a chance and could only be repeated under exactly the same conditions. So I believe its little value should be recognized especially as it convinced me that you will not be able to replace the string. You admit two things, namely that it is hardly probable that this affidavit will cause the commission to grant a patent; and between you and me they are right; furthermore if they should grant a patent it would have very little value.

I think that you had better wait for my two latest ideas; and if there is something that merits a patent, go to it, by all means. Plenty of caution is never harmful.

What I have to do now is get to work and compile my scattered notes on these two machines. Fortunately for us the summer has not been too hot. I have not been affected and I seem to emerge this year rapidly from the depression which Europeans usually experience in autumn. I therefore hope to be able to present to you something interesting. In other words it will be my theory of flight without flapping wings incorporating the latest developments.

I read once more the last sentence of your letter: "According to the examiner, the airplane cannot take off without a balloon." He is right. I only saw the contrary of it in case of an ascending current on a machanical airplane; the animated airplane, the bird, makes use of the energy and its actions and of the wind in order to overcome gravity.

My dear sir, I wish that you may recover a good part of your interests agreeable to your wishes.

With an affectionate handshake I am

Mouillard

In l'Illustration of Sept. 25, I read a note of a few lines which said in substance that the U. S. Government proposes an amount of \$200,000 for a torpedo which could evade nets. My No. 3 meets precisely this requirement. Is there any possibility that Mr. Langley might reconsider or could it be presented to others? Please give me an answer to this subject in your next letter.

December 6, 1893

Mr. L. P. Mouillard
Dear Sir,

I have to ask your pardon for having delayed for such a long time my reply to your two kind letters of Sept. 10 and Oct. 14. A few days after I received the first one, the loss of my old mother caused me great grief; then I took sick, and this together with the financial worries prevented me from writing even to you.

I feel better and, although circumstances do not permit me at this time to make your personal acquaintance, I am still hoping to put our theory into practice. And I am anxious to meet you.

As a preparation I am returning to you under separate cover the rest of your book and put 2500 francs at your disposal to have it published. Make any changes you wish, but send me the proofs as your work progresses so as to enable me to correct my translation accordingly.

I was under the impression that your article would appear in the December issue of the Cosmopolitan for I have been proof-reading it more than a month ago. I received the magazine yesterday (I am sending it to you), but the article is not in it. The publication of the excerpts of your "L'Empire de l'Air" has been delayed due to the special session of the U. S. Congress which put a strain on the facilities of the U. S. Printing Office.

I think it will be better to refer your torpedo to an official of the navy rather than to Mr. Langley. The latter is so busy that he has no time to spend on things in which he is not keenly interested. Even on the subject of aviation he sends me notes written on slips of paper. If you approve of it, I shall go to Washington to find out who will be the proper party to get in touch with.

I still disagree with you on the subject of the usefulness of an affidavit of your experiment at Mitidja. First you will see in my December article (which I am sending you) that Mr. Montgomery of California has made almost an identical experiment, and then in the same article you will notice that Mr. Huffaker has reproduced gliding flight automatically by means of a concave-convex airplane which takes off backwards, a possibility of which I have been well aware.

As we already have had expenses for this patent I think it would be wise to keep it up and to confound the examiner.

I am sending you the publication of the papers presented at the Aeronautical Congress.

Sincerely yours,
O. Chanute

December 18, 1893

Mr. L. P. Mouillard

Dear Sir,

On December 6 I wrote that I was going to send you the rest of your book, however I did not mail it before today. I wanted to review it once more to check my translation which, I notice, lacks color very much. I enclose a list of the chapters each envelope contains.

I have not translated "le Desert" because you informed me that you have decided to omit this chapter. It contains many fine pages of which you could make use in other parts of the book.

Neither have I translated the "Causeries" (chats), which, by the way, is the finest chapter of your book. I want to leave it for the last, at a time when I shall feel better disposed in order to present in English that glowing and colorful style (which is very difficult to do) which fascinates the reader. I tried to do it the other day, but I failed terribly. I am too tired and I shall have to translate this chapter (also I think, other chapters which you did not send me) when your book is in the press.

Mr. Langley wrote me that the translation of l'Empire de l'Air (the one which has my O.K.) is going to be published in January. I believe that the article in the Cosmopolitan will appear at the same time and that your paper I presented to the Aeronautical Congress will be printed in June. These "American reverberations" should spur the curiosity in France and so prepare for a market for "Le Vol sans Battement." I therefore advise you to get busy and find a printer or a publisher.

I kindly ask you to have a translation made of my article in the December issue of the "American Engineer" and also the one that will be in the January number. You will note here (these are the last ones) that I greatly recommend that an initial experiment be made without motor, even if later on we have to use one. I still think that true balance is the stumbling block. You will greatly oblige me by giving me your opinion of my conclusions.

Let me know also what your plans are to go into the application of your theory and how much you think it will cost to carry out the proposition. I know how hard it is to make such an estimate, but after all, you are in a better position than anybody else to do so.

I wish you a happy New Year.

Very truly yours,

O. Chanute

Envelope

10. - Fableau -- Etudes d'oiseaux
11. - Etudes d'oiseaux: Licmetis Nasiscus [!]
Goelands et Mouettes
Corbeaux et Milans
Garde Bœuf
Fuffinus Kulhii
Oiseaux du Cairo
12. - Cerf-Volanta Cerf-Volant Voila
13. - Ballons -
Ballon
Ballon Alpestre
Etude de l'atmosphere
Soupage de Ballon
14. - Parachute
15. - Causeries -
Aphorismes
Arret de Penetration
Mechanique de l'oiseau
du choix dans l'observation [!]
Angle d'attaque
Apropos du Vol Théorique [!]
Necessite de l'observation des
Voiliers
du repos en aviation
Aspect de l'aeroplan
Hiatus
Demonstration par l'experimentation
Ornithorium
Conseils d'ami
Adieu
Résumé
16. - La Désert

January 7, 1894

Mr. L. P. Mouillard

Dear Sir,

Two days ago I received your kind letter of December 10. I shall read it carefully and give my answers in a separate letter.

I am writing you today to inform you that on February about twenty of my co-citizens will leave here on a Mediterranean tour. Among them is Mr. James W. Scott, owner of two daily newspapers (the Herald and the Post) who is interested as an amateur in air navigation.

I gave him a letter for you. He will be at the Shepheard's hotel on February 23. He does not speak French, but his wife will act as an interpreter.

I am glad that you are going to get acquainted with these Chicago gentlemen and am sure that you are going to show them some of your airplane experiments as well as your vultures, because I have a notion to invite them afterwards to join me in order to enable you to go ahead with your experiments.

I am sending you the January issue of the Cosmopolitan. Your article is not in it. I do not know why. It may be possible that the Chicago gentlemen may get the February issue before leaving New York. May I call your attention to an article on page 382 of the January number by Gaston Tissandier who always dabbles with balloons. Note also, on page 63 of the advertisement section, an offer of 25,000 francs for a 100 h.p. engine weighing 228 kilogrammes including water and fuel for two hours. About four months ago Mr. Walker asked my advice in regards to this advertisement, and I told him that this offer was not practical.

I wrote you on December 6 and 18 and sent you the rest of your book on the latter date. I keep my fingers crossed so that the book may arrive in good condition.

I am told that there is a short newspaper report which tells that Lilienthal has succeeded to climb while gliding. If I can get hold of that article I shall enclose it in this letter.

Very truly yours,

O. Chanute

January 8, 1894

Memorandum for Mr. Jas. W. Scott

Mr. Mouillard was born in Lyon-France, and must now be about 58 years of age. He was "enthused" at the age of 15 by the problem of flight, and has spent his whole life in watching the birds, and in musing how to imitate them. While still young, he purchased a farm in Algeria, so as to study the soaring birds, and there built two or three machines, with one of which he succeeded in gliding on the air some 132 feet, but subsequently met with an accident. He then designed and partly built a better machine, but, his health failing, sold out his farm and removed to Cairo-Egypt, where he engaged in the business of a druggist.

In 1881, he published a record of his observations of birds, "L'Empire de l'air", which excited much interest, and of which the Smithsonian Institution is about to publish a partial translation. He has since written another book, "Le Vol sans Battement" which has been read by Professor Langley and myself and which is about to be published in France.

He thinks that he is now prepared to build a machine with which a man can soar like a bird and I believe his success to be possible.

An article by him is now in the hands of the Cosmopolitan magazine for publication.

January 8, 1894

Mr. L. P. Mouillard
Cairo-Egypt

Permit me to introduce to you Mr. James W. Scott of Chicago, the owner of two large Chicago newspapers. I kindly ask you to put your familiarity of Cairo at his disposal.

Mr. Scott is also interested in the problem of air navigation, and I have spoken well of you to him.

Very truly yours,

O. Chanute

January 18, 1894

Mr. L. P. Mouillard

My dear sir,

With great interest I read three or four times your letter of December 10 which gives a description of your improved machines.

I am not quite certain that I understand them perfectly; first, because my mind is still somewhat affected due to my indisposition and then because you passed over many details in silence.

Yet I think I should tell you that these improved machines are too complicated to start out with. There are two principal questions I would like to have settled: 1.) Whether the machine is capable to create "suction" with flat surfaces, 2.) whether it will maintain its equilibrium in vertical air currents. You have no doubts about it but it seems to me that your first machine (the one submitted for patent) was better fitted to demonstrate the sufficiency of your general design; especially in view of the difficulties caused by the resistance of materials and by the necessity to execute certain maneuvers very rapidly to parry oblique or vertical air currents. I gladly believe that your "spiral and moving quarter circles" should be added to the "first machine", but that the addition of a fuselage could be delayed until the success of the first machine is assured.

In order to accomplish this it would be sufficient to take off from a small steamboat which moves against the wind, as I have mentioned in the last article of my series (January 1894).

All one has to do is to put on a waterproof suit and a life belt. Then if one drops in the water with or without the machine, the boat will quickly come to the rescue. This method is, after all, better than to plunge in head first, entangled in a fuselage of your improved machine.

Therefore, I believe the thing to do is to build a machine of bamboo just large enough to take-off properly (14 to 18 square meters) to equip it with the parts which are absolutely necessary and to employ an acrobat to assist you.

Fly freely one or two kilometers with this machine, and money for the improvements will be abundant.

Please let me know how much you think these first trials will cost as perhaps we have to pay for them ourselves.

I have not yet organized the society to carry on aeronautical experiments. I am counting somewhat on the good impression of you on the rich men from Chicago whom I introduced to you. I know several of them, but only slightly, and I have only talked to two of them about you. One is Mr. Scott who is inclined to believe in an ultimate success, and the other Mr. Ayer has no faith in it at all. Although he is an enthusiastic ornithologist he is not interested in flight whatever. I have made a subscription in your name for "Aeronautics." I am going to write you a separate letter about Lilienthal.

Very truly yours,

O. Chanute

January 18, 1894

Mr. L. P. Mouillard

Dear Sir,

I got in touch with Mr. Whittlesey, the patent lawyer, to learn whether the interests of your invention would be affected by the publication of Lilienthal's experiments, in case the newspaper article which I sent you turns out to be true.

He tells me that in the United States we are protected since we have made application (for the patent), but not so in Europe. In Austria, Belgium, England, Italy and Spain, when this publication in each of these countries precedes the description of an invention, no patent may be issued. In France, Germany, and Portugal the publication does not affect or prevent the issue of a patent. In Sweden and Norway there is a respite of six months from the time this publication appeared; thereafter no patent will be issued. In Denmark and Russia the previous publication does not prevent the granting of a patent, provided the public has not made use of the publication.

He also says that it would perhaps be better to bring the expiration date of the U.S.A. patent in conformity with those in Europe (3 or 4 years I believe) than to be deprived of those patents entirely, and that in this case we could make patent applications without waiting for the patent to be granted in this country. What is your opinion?

The question is to know the construction of Lilienthal's machine. It has been photographed but the pictures hardly reveal how to classify it and how simple it might be. From the small pictures I sent you, I had enlarged blueprints made which I enclose in my letter. Note the projections half a meter from the inner tips of the arms. They look to me like ball and socket joints which snap together when the machine is in action. Are they taken off when the machine is photographed?

Note also what I said in my articles on Lilienthal (July and August 1893). He started out with 10 square meters, went back to 8 square meters, then this year he uses 14 square meters (20 kilos). Having started with a descendent glide, it therefore seems possible that he has acquired enough skill to use 14 square meters and to ascend while gliding. I believe that he controls the machine by displacing his weight by means of the force of the wrists and the elbows, as well as perhaps by means of opening and closing the wings and that he may have for this purpose a spiral spring in the ball and socket joint which however seems doubtful to me. Finally there is a possibility that Lilienthal will not divulge anything about his machine before we have everything in right order.

Perhaps you could expedite matters at the U. S. Patent Office by sending me a small model through the American gentlemen who are going to visit Egypt.

Yours very truly,

O. Chanute

January 18, 1894

Mr. L. P. Mouillard
Cairo, Egypt

Permit me to introduce Mr. E. E. Ayer of Chicago who is much interested in ornithology.

I think he will be pleased to see the curious maneuvers of the soaring birds, which you have been observing all your life.

Respectfully,

O. Chanute

Cairo
January 20, 1894

Mr. O. Chanute, Engineer
Chicago

My dear sir,

I herewith acknowledge receipt of my book.

On December 10 last I mailed you a registered letter which contains the description of the two airplanes I intend to build. I am sorry that their description turned out to be so brief, but I came to this decision in order to make things more clear; however I am keeping at your disposal every detail of any part which you either could not comprehend or in which you would be interested.

As you see I have decided to act boldly. I think it is up to me to do so, understanding as I do that the impression of flight maneuvers which I gained by means of thousands of observations cannot be inculcated to others by means of a written description.

I am so sorry that you could not make it possible to spend the winter in Cairo. I am convinced that our conversation and the sight of the soaring birds would have been absolutely enlightening.

I am

Your very devoted

Mouillard

Cairo
February 3, 1894

Mr. O. Chanute, Engineer
Chicago

My dear sir,

The newspaper article you enclosed in your kind letter of January 7 had me stupefied. According to it Lilienthal has flown. This seems plausible. I, for my part, believe it because an experiment which is repeated and improved until it leads to ascending flight seems to me to be a sign of truth. I think we should have no more illusions about it, and accept the accomplished fact. Several people have sent me French newspaper articles which tell the same story. The question now remains, what is to be done about it.

First, what is he going to do? He may learn slowly how to fly well, and because he lacks teachers he will have to guess how to do it. I don't think he intends to reserve the atmosphere for himself as private property, certainly not. But he is bound to think of making profit of his invention by having the machine patented with which he made that flight. In France, at least, this would be rather difficult, for he may be told that "L'Empire de l'Air" has treated the problem a long time ago. Admitting that he has applied for a patent, even that one has been granted to him which is rather probable, the question is to do better than he has done; or, if the picture you sent me is true, it is easy to produce something better. The first airplane I sent you in 1892 is much more practical than his, and the two recent ones are of better advantage yet. Their greatest shortcoming lies in the fact that they are in the designing stage.

The examiner who refused you a patent ought to feel very sheepish now, since Lilienthal has demonstrated that he can make an ascending flight. I am sure that henceforth he will not refuse any more patents on his own authority.

As far as I can see, this matter is developing into a race for speed to be won by the party who succeeds fastest to produce a practical machine. In order to do this, it will first be necessary to build and then have it operate.

I am impatiently waiting for a letter from you in which you tell me more about Lilienthal's flight demonstration. As you, no doubt, are in touch with German you should have no trouble to get correct reports. As soon as you receive some, please send them on to me. After the problem being given such a start, I think that it is going to be tackled from many angles by many different methods; therefore this is the moment to secure a proper place by building good and practical machines which are

easy to operate. It seems to me that I do not exaggerate when I say that as far as considerations are concerned I have the advantage over my competitors in the line of ideas; it therefore would be well to take advantage of this fact so let us go ahead with the patents and the demonstrations.

As this question is one of the desiderata of your life, I believe that you are as anxious as I am; I therefore kindly ask you to write me about this matter as soon as possible for I think nobody is going to fall asleep now and the road to be travelled now is going to be travelled as fast as fire along tracks of blasting powder.

On February 24 I shall be at the Shepheard's Hotel to see Mr. W. Scott and your friends. I shall try to make them understand gliding flight by showing them how this flight is accomplished without any exertion of force by the small vultures which will be ready to demonstrate. As to the large vulture, this is a different matter as I am not certain whether I shall be able to show them; as this bird becomes rarer and rarer, it simply means taking a chance; the Englishmen hunt them to extermination.

Lilienthal's experiment has changed my opinion fundamentally. There are some points which I cannot grasp very well. Indeed, he reaches an altitude of thousand feet, higher than the Eiffel tower, and lands before nightfall. Therefore did the wind decrease suddenly?

He glided alright, for his machine being of the flapping wing type should be able to make at least some fifty flapping motions which, by the way, would be more figurative, but not effective at all. I have tried this kind of flying for a long time with my No. 3, with the de Massia airplane and finally with my No. 4 (Emp. de l'Air). I found this kind of flying so troublesome that I considered flapping to be impractical. I even wrote in "Vol sans Battement" that the simple stand on the extended wings causes so much trouble that the problem has to be reversed, in other words to transform the flapping wing airplane into an airplane with fixed wings. Therefore, it seems very probable that Lilienthal's flight was made without flapping wings.

What will be your decision in this matter? My opinion would be to hurry and do better; unless we decide to lose everything we ought to do something. It is a simple question of money and Lilienthal has demonstrated to us that the problem which I have so much propounded is true. As we know it just as well as he does, it seems to me that it would be a crime to stand by

with folded arms and watch him make his flight experiments.

Please give me your reply at the earliest moment; now, time is money.

With an affectionate handshake I am

Your devoted

Mouillard

February 9, 1894

Mr. L. P. Mouillard

My dear sir,

I received your letter of January 20 and feel greatly relieved to know that your book has reached you. I still have 2500 francs at your disposal to have it printed.

I am glad to note that you have decided to make the first experiments yourself. By the time this letter reaches you, you may have seen Mr. Scott and his friends. When they come back home I intend to ask them to join me to supply you with the necessary funds. I believe your experiments should be made in Egypt or at least in a country where there are soaring birds in order to have the same conditions. It ought to be very simple to build the machine because I advised you to use bamboo instead of aluminum. The latter could be used for the hinges and perhaps, if need be, they could be gotten in France according to your drawings and models. For the rest I think you may find some mechanic in Cairo. Lilienthal's machine is made of wicker which is much heavier than bamboo or agave and yet it only weighs 20 kilogrammes. Do not make too large to start with; I think 15 kg will be sufficient. See what Lilienthal had to say in my article (July and August).

Your article has been published in the Cosmopolitan on February 1st. I asked the publisher to send you a dozen copies and I wrote him again so he keeps you in mind. Moreover, I mailed you three copies from here and ask you to let me know if you need more. The publisher cut short certain passages so as to fit the make-up. You also may note that I added the descriptions of the pictures according to your supplementary letter.

The publication of the Smithsonian which should contain the translation of "L'Empire de l'Air" has not come out yet. I expect it any day now.

I deplore with you that I could not come and spend the winter in Cairo, for I have just had another loss of 25,000 francs, which would have been more serious if I had been out of the country.

Very sincerely,

O. Chanute

March 9, 1894

Mr. L. P. Mouillard

My dear sir,

In the same mail which brought me your letter of February 3 I received a booklet from Lilienthal which contained the article which has been translated in the January issue of the "Aeronaute". In this translation the article has been curtailed, garbled, deprived of practical information and very poorly appreciated besides. It took me several days to make a good translation of this article. After I have it proofread you may find it in the next month's issue of "Aeronautics" which magazine I am having sent to you regularly.

Lilienthal suggests frankly to all investigators who think to have some ideas to imitate his experiments, and he points out what precautions to take to avoid accidents. He says there is room for everybody and tells what he is going to do next summer. I suppose those who clipped these sentences off his article intend to follow his advice, but they have to be careful not to break their necks.....

There is another point: what may happen to Lilienthal when a gust of wind strikes his machine from the rear. He is very cautious, very wise, but he is taking a great risk by installing an engine from now on. He is not lacking any models, for he has the stork and the falcon but he is quite certain that you understand gliding much better than he and that your machine is better designed than his. I therefore agree entirely with you that it should pass the test. What I want to know is where, how, and what it will cost. I should be very glad to have your opinion on this subject.

It is also obvious that now is the time to get busy with your book, without altogether revealing the practical construction of your machine. Lilienthal, although very frank, does not give away any secrets of his airplane. I wrote him and sent him the articles in which I wrote about him. He sent me his article without any letter. Under his signature he publishes only his experiences during descending or undulating flights, but I agree with you that he did make ascending flights as stated in the small newspaper item I sent you, which (as I have learned since) came from the Russian magazine, "Technik."

Will you kindly inquire whether Sir Benjamin Baker, an English engineer is in Cairo now and how long he intends to stay in Egypt.

Very truly yours,

O. Chanute

Cairo
March 10, 1894

Mr. O. Chanute
Chicago

My dear sir,

I have delayed to write this letter, because I am absolutely embarrassed by what happened to me. I have not seen your American friends.

On February 24 I went to the Shepheard's Hotel. My calling card was sent up to Mr. James W. Scott and Mr. Ayer. I was told that the gentlemen are not in. The next day I called again; again not in. The following day, the same procedure. Listen to this, I wrote Mr. Scott a letter in which I gave him my address. No reply. Then I went from one hotel in Cairo to the other and was convinced that they are at Shepheard's alright, but that they did not want to see me. I am sending you a copy of the newspaper which has the passenger list, so you may convince yourself where they stopped. As I only know the name of two of the gentlemen I cannot decide. I did not find Mr. Ayer, but Mr. & Mrs. Scott must be in suite No. 53 of the Shepheard's Hotel.

I do not know what to make of it. It cannot be my person which displeased them, because they do not know me. It is not my reputation, because I have none, neither good nor bad (my acquaintances say: good). Finally I got hot under the collar. The whole matter is too bad, but I could not do anything about it; I could not violate the sanctity of their abode nor could I obtrude upon them further than sending them my calling card three times and a letter carried by my servant.

Let us forget these experiences and whatever may come out of them, since chance has disposed of them, and let us pass on to other matters.

What are we to do now? What road shall we follow? Which is the best way?

To publish my book would give Lilienthal the information he is looking for: the means to make turns in flight, which it seems he has not yet discovered; to convert him to gliding and ascending flight in place of a more or less slow drop? To have him examine the bird; to teach him how to float instead of falling within the longest possible distance? Or shall I do it myself? I am in a rather inconvenient position for this purpose. Lilienthal, it seems, has unrestricted freedom which I have not. I have only 4 hours at my disposal between evening and nightfall and then I am in the city. To get to a site where to make experiments will take several kilometers, all this is hardly practical. Yet the system of the airplanes which I commend is far from the one on blueprint which you sent me.

I have pondered over your idea to disregard the airplane which rests on the water and to transform it into an airplane with wheels, which could be moved on the ground. This is a change of details: to move on water or to move on the ground is practically the same thing. I have the facility of vision - the rocket is always the engine, the propellant.

If I should succeed to get a position I applied for, the question would be very much simplified. I would live in the desert and there I would have every facility for experiments while being employed and paid for, for living there. But this is not yet an accomplished fact, far from it. I must have this job.

I have read the article on Lilienthal in "L'Aeronaute" over and over again. According to what I read it seems to me that Lilienthal has gotten as far with his design as my airplane No. 3.

How would it be to get in touch with him? Please try to make this possible.

With an affectionate handshake I am

Your devoted

Mouillard

Cairo
March 23, 1894

Mr. O. Chanute, Engineer
Chicago

My dear sir,

I did not see your American friends, but it must be remembered that trying to meet them was not an idea of mine. It is a deplorable affair, but what can be done about it? They did not want to see me, and I could not insist.

In my last letter I forgot to tell you that I subscribed for Aeronautics. You have been kind enough to do the very same for me. I thank you very much. But as this would be a duplication, I better inform you of the actual fact, so that you may get your money back. If I remember correctly, the subscription price is \$1.20.

I regret more and more that you could not come to Cairo. How many things could we have accomplished within a few days! You could have seen how the proposition stands and you could have formed an opinion of what to do. Your Mr. Scott and your other acquaintances could have had a hand in the work to be decided, but they did not want to do it. I looked forward with the greatest of pleasure to meeting them, and I believe that I could have made a favorable and pleasant acquaintance among them. I expected to be able to be of assistance to those who paint, as among the baggage were boxes of aquarelles and albues of gentlemen interested in ornithology, geology, etc., even in Egyptology; naturally I am a colossal authority (in my fashion) on Egyptian antiquities. If there is anybody who has an obsession for the prehistorics, you need go no further to look for him. This is not more than natural. I have spent almost thirty years of my life in this country, so I had plenty of time to ponder, and as I am very curious to study hard. Prehistoric study is something to shout about. It is just made to order for me, but I lack the time to give it much attention - there is a probability that their lack of knowledge of French and mine of English has been the decisive factors that your friends and I could not get together. If so, they were entirely wrong, for when one is informed, one always may be understood. Once, in Port Said I had a discussion which lasted for three days with Herr (I forgot the name), director of the anatomical department of Vienna. He did not know a word of French, nor I of German. How the people at our dining table laughed! And yet, we did not stop. Between scraps of Latin and Greek we always succeeded to understand one another, except however we could not agree on the primary object of our discussion. By chance we were placed side by side at the table. Herr X pulled some stones out of his pocket and put them on my side of the table. I looked at them through the corner of my eye and said, "Pliocene;" he answered, "Eocene," and so started a three days' discussion. The assistance of a crew of young Dutch officers who came ashore was needed to reconcile our opinion, and in spite of it, this was no easy matter.

Which goes to show that when there is something to be discussed, there is always a way to make oneself understood, especially if the subject is interesting.

How about Mr. Otto Lilienthal? What became of him? Why did he not go around this world yet? I must confess that I have been looking for him, way up in the air, because straight flight is the easiest kind to learn. According to my experience the straight flight is easiest to learn. The newspapers no longer write about him, how is that? If I was in his place I certainly would have seen many countries. Therefore, the conclusion may be drawn that he has not mastered flying yet. I state once more that it is just as easy to fly 100 kilometers as it is to fly a single one. There is a fact for which I have no explanation, which, even causes me to doubt the veracity of what I have read. The difficult part is to take-off and next to land. He did both many times, but he never took advantage of gliding which becomes an effortless automatic motion and which is merely a question of the length of time to remain over one point of the ground. Here, dear sir, is something which needs more explanation.

As the matter looks to me from here where there is little up-to-date news, I imagine rightly or wrongly that in the development of his machine he has reached the point where I found myself at the time of my first experiments in Algiers when I was aware of the fact that my airplane lacked control devices. It seems to me that he is exactly in the same position. He is wise enough not to understand that he is not master of his machine causing him to be afraid to jump off and (read the chapter Effect of Speed E to l'A).

Therefore, it will become necessary to outclass him in speed and to do better than he does. This would not be plagiarism for the public will be aware that the publishing date of "L'Empire de l'Air" is 1881 and even if it dates back so far, that it contains the rudimentaries of so many things pertaining to aviation of which Lilienthal has not even caught a glimpse, especially the very enthusiastic description of gliding.

If he had very exact controls and the understanding of how to fly, the best way of take-off for him could be not by means of dropping but horizontally and in this way get into ascending flight. Therefore, according to what I have been able to learn about him, he is learning to fly just now, and having no prototype he is learning without a teacher. If I only had several thousand francs to apply to this study I would try to take a jump at this problem. I very firmly believe that I could put into practice the primary study I made thirty years ago, and so transform the parachute machine into a high-speed airplane •

To do this, I would first need a place where I could build an airplane which has a surface of 40m² and a span of 15 meters. To build such a large machine aluminum would be absolutely essential and at its actual price of five francs per kilogramme would not incur a big expense.

I need two large sized bicycle wheels to move the airplane on the ground. The floating system will be reserved for the large aircraft which I have in prospect but which will remain pending until I have been successful with my first experiment. The money to build it, after my success is assured, may be easily raised, even in Cairo.

Finally I shall make tests with rockets, various types of bamboo and fabrics. I also shall need workmen and watchmen; but all this ought not to run into much money.

The most delicate problem is the testing ground because I feel the same way as the American investigator who went out west in order to have no onlookers during his first trials when there are always some mishaps which give rise to ridicule. This would mean some expenses with which to figure, yet I think 2500 francs ought to cover them all. It is obvious that in case the experiment is successful, everything has to be done over again; but then the whole matter becomes easy, so one knows what it is all about, one knows pertinently that this is only a question of improving, in short of pure details, even if it means to rebuild from top to bottom. Finally, Otto Lilienthal has a good deed to his credit, as follows: I made a statement without any proof to support it, that the air carried me, now he is the one who demonstrated it; this is a point which is decidedly cleared up.

With an affectionate handshake I am

Your devoted

Mouillard

P.S. The small airplane you recommend would be alright if I were 25 years old again. I therefore have to get around the difficulty. For that reason I have been thinking of a boat. Noting however that this would be an expensive proposition, I have transformed it into a bicycle which by means of a rocket will move an airplane. These are nothing but simple adaptations. The airplane parts are not changed. Instead of a boat, two wheels have to be moved. The tests are made on the sand of the desert instead on water. The starting in this case may be somewhat harder if the airplane is not kept parallel with the ground. But sometimes this has to be done in order to have a greater range of vision while there is unrestricted vision on a boat.

Cairo
March 30, 1894

Mr. O. Chanute
Chicago

My dear sir, -

I received your kind letter of March 9 and I hasten to answer the questions it contains.

Mr. B. Baker has arrived in Egypt about three weeks ago. He, as well as a French and German engineer received a call from the Egyptian government to give an opinion on huge reservoirs to be built as a means of flood control of the Nile river. This is a reedition of the ancient Lake of Mocris of Ousarirtoson II of the XIIth dynasty. The idea certainly is not a new one but practical just the same. The costs are estimated at from hundred to hundred and fifty million francs.

Although I am in a good position to know I could not make out definitely when Mr. Baker is going to leave. According to some sources it will be within a few days, according to a general rumor (local papers) it will be much later than anticipated because he is going to work out his own project for these dams. According to my own observations (I spend my forenoons in a room adjacent to that where the discussions take place) it seems that there is agreement between the English engineer Wilkocs about the examined projects and their investigation. I therefore think Mr. B. Baker will leave shortly.

The discontinuance of Lilienthal's experiments are puzzling. Does he perhaps make changes on his machine or build a new one?

I consolidate the adaption of my airplane to run on the ground. As far as it goes it will be very much simplified as a machine for the first experiment. But I am more and more convinced that in order to build a machine large enough to be used for practical flying, it will be necessary to take-off from water, to use aluminum as construction material, and automatic control devices. At the moment I am working on the demonstration machine only.

I confirm my two letters of the month of March.

With an affectionate handshake, I am

Your devoted

Mouillard

Latest report: The evening paper says that Mr. Benjamin Baker is going to leave on April 5th.

March 31, 1894

Mr. L. P. Mouillard

My dear sir,

I have just received your good letter of March 10. I am, just like you, all upset by your being prevented to see the Americans. I don't understand it, but you are right to say that there are other things to think about.

I regret very much not to be rich enough to be able to tell you to leave all your other interests, to go and establish yourself at the place most suitable for the experiments that you want to make, and to try one machine after the other until your complete success, or until you are convinced that you cannot succeed and that in the latter case I would be able to tell you that I would give you back your former position. That is what a group of amateurs would be able to do, and, as the French aviators are very vexed to be outdistanced by a German, they may make such an offer. In that case I will not be in your way, if I am not in the position to make the same proposition.

Passing on now to the things that you ask: 1. I believe very firmly that you must make tests yourself. As I wrote you, I am convinced that you understand gliding flight infinitely better than Lilienthal. But it doesn't follow from that that you shouldn't publish your book for fear of giving him what he looks for. On the contrary, I think it good to make use of the interest for the subject at this moment to attract attention to yourself by publishing your book omitting the details of the construction of your own machines that you want patented.

2. I see that I didn't explain well what I meant about the airplane that will come down on the water. I simply think to delay that in order to have not too many complications in the beginning. Lilienthal climbs on a hill with a rudimentary machine, he gains speed by running (watch out for the rockets) and throws himself in the wind; later on he will think of starting on level ground. Do like him, or start from a height or from a steamer and fall into the water which is much safer than landing on the ground. I am very much afraid for Lilienthal that he is going to break his legs next winter if he continues his exercises on the mountains of Bhinomer. To glide against the wind that may be, but for the ascension and the gliding through (across) the wind, it's dangerous.

One of the things that I consider the most important is to have a very regular wind and not too strong. That is why, according to my idea, one risks failure if one makes the experiments in parts where there are no soaring birds.

3. I don't clearly understand what you mean that the whole of the airplanes that I prefer is very far from the one traced in blue that I received from you (for your patent). Do you mean that you have changed your opinion on the construction of the machine? In that case I want you to tell me your new ideas, (a) to have them included in the patent that you ask for in the United States and that I shall not pass on before I receive your answer, and (b) for my special information. I am not sure to have understood your idea very well and I may even tell you that I hadn't understood the practical construction of it by reading your book, and that is only when we got to the patent that I saw more clearly that which came out of your observing the birds.

4. I understand that a place in the desert to make the preliminary experiments is very tempting. There are two inconveniences: (a) the delays in making the repairs of the broken parts; it's of little importance; (b) the danger of not being well taken care of if an accident happens. That is important and if you decide to accept this place, I beg of you to make arrangements so that you are not alone. A practical surgeon or medic would be what you need even if you had to pay him money.

What makes me think of asking again how much these experiments will cost.

5. I don't think there would be any advantage for you to get in touch with Lilienthal now. If he breaks his leg, maybe then.

Have you received my letter of January 18 sending you the enlarged photos of Lilienthal's machine? In this case, write me some criticisms and tell me if you have understood the construction.

Have you received the 15 issues of the Cosmopolitan which have been sent to you from New York and from here. In this case are you satisfied with the engraver and the editor?

I also wrote to you February 9 and March 9. I believe that we would avoid misunderstandings if we would acknowledge receipt of letters with the dates.

Do you receive regularly "Aeronautics"?

I haven't yet received the paper of the passengers that you wrote me about. It will probably arrive one or two days after your letter.

If I find time, I'll make you a translation of Lilienthal's article that was omitted by Aeronautics in order to inform you well of what you are going to get in English in "Aeronautics."

I shake hands very sincerely

O. Chanute

Cairo
April 20, 1894

Mr. O. Chanute, Engineer
Chicago

My dear sir,

I am going to answer your kind letter of March 31 at once and am taking it line by line so as not to skip anything.

I have no sign of life of your American friends. I do not worry about them any more. The first blows of the desert wind caused every stranger to leave; none is to be found in Cairo; everything is very quiet. But it is not hot yet, 20 to 25 degrees C at noon. However these winds from the south, south-east, and south-west which passed over the desert sand are very uncomfortable, especially at night when they prevent sleep because of their electric action; then they carry much dust. This is the time to protect your eyes and watch out for fevers, etc. Even the small vultures are not pleased; they have to battle against wind which is too strong for their overstretched surfaces. This provides us with the spectacle of a permanent struggle for forward flights. Neither a large nor a small vulture is to be seen. This air current is too strong for beasts and men. There is a lesson to be learned of what to do when the wind blows too hard: To go outside only by walking where the wind will drive you. Even if one walks with the wind or if one tries to cross it, its velocity is remarkable - 25 meters per second, which means about 90 to 100 kilometers per hour and perhaps more in high altitudes. These are not the regular winds of Egypt, but an exception, because of the equinox, the equilibrium to be established between summer and winter. The ordinary winds of Egypt are very much milder and more regular; they are entirely like those which I observed in France and in Algiers. Besides, if these desert storms should last long, they would force the small vultures either to leave the country or to impair their plumage. This climatologic digression is meant to convince you that the winds which predominate in Egypt, as far as velocity is concerned, are absolutely comparable with those of other parts of the globe. There is even a tendency toward a regularity which is not noticeable either in your country or in France, that is the absolute absence of thunderstorms, no thunder claps, no lightning. During the past 30 years I have experienced only four or five thunderstorms. There is only the perpetual and unalterable blue (of the sky), except for a few days in winter. The soaring birds of Egypt would elsewhere go through the same flight motions as they do here. According to your letters you seem to doubt this fact. In your country and in France there is no lack of proper wind, but the "professors" are absent.

1) I agree with you. As soon as I start to build I have to publish my book simultaneously. Between reading and understanding, between understanding without having seen and being convinced, and between being convinced and to decide to build, there is a lapse of time, too long to be overcome. However, I have to revise my book and add and change quite a bit. I shall present all the principles without giving any construction details.

2) Certainly, what I had in mind was the large airplane, consider the cost of this machine. I understand perfectly that it will take a long time and large capital in order to bring it to a successful conclusion. Yet I shall not be able to build it in Cairo. I think Paris may offer the best facilities. But first Lilienthal must be beaten and hundreds of kilometers must be flown. When this is accomplished one could devote oneself completely to the above task. Capital is going to flow in. For demonstration purposes I intend to build a bicycle to which I shall fit the airplane. In this way I will have launching facility - my muscular power (to cover 100 meters as fast as possible), and, if need be, the rocket. By the way, please tell me all you had in mind when you said "do not depend on rockets". It certainly would be better for take-off and landing on water. But living aboard a ship, experiments on the Nile seem very expensive to me. I must have a "Dahabieh" and a crew for the itinerant sailors are not to be counted on; in short this will be for the time these experiments could be made.

3) I have no copy of the letter I wrote you, but I think I wanted to talk about Lilienthal's airplane. It cannot be anything else. As to its application to the machine you are about to have patented, it would not be suitable for me, for the simple reason that the airplane has got to carry me and not vice-versa. The latter would be very good if I was 25 years old, but today I must resist doing so. To carry them (the airplanes) around is a memory of my youth. Besides it is not more than right; I had them long enough on my shoulders to know that they tire you out; it is their turn now to carry me.

4) The desert and its disadvantages of which you wrote are much attenuated in Cairo. The desert is at our door steps; it is reached by railroad and there are towns in the desert. I intend to select a place either in the northern part on the route to Matorich, or in the South at Helouan les-Bains. At Helouan I would be well fixed; there is a physician, a pharmacist, some friends who live there and who could help me with my experiments; the desert will be at my door and on this desert not a human soul; I therefore shall be unmolested. As to the job I mentioned, it is still very remote, depending on a political question beyond my control. This certainly would be the best position to come my way, and while holding it I could make my experiments at Helouan. I think that under these conditions and for that simple demonstration airplane 2500 francs would be sufficient. I intend to build it partly of aluminum, partly of bamboo, and even to use steel for the pivots and other points where no other material will do.

5) As far as Lilienthal is concerned, you are right when you say that he goes his way, and I go mine. This will be the best way out. As I stated to you previously, I received the two enlarged pictures of Lilienthal. Despite the enlargement I cannot understand at all his mode of suspension. It must be very bad and cannot maintain a position for a very long time. As I can see it, his vertical control is a result of the displacement of his body, but as you may have read in my second book, this displacement has little effect. The horizontal tail may produce it if the airplane is in a straight line but that is a very imperfect method. It seems to me that he gets horizontal control by means of the vertical control surface, which is another method that operates in proportion to the actual speed of the airplane. This is not the method used by birds. The two means which I use for this purpose are much more efficient and much more rational than his, because I have copied them from nature.

I am getting Aeronautics regularly. I am sorry to disappoint you about the passenger list. When I was about to mail it to you, I discovered that my housekeeper has used it to wrap up something.

You would greatly oblige me if you could send me a translation of that part of the article which was left out in "l'Aeronaute." It is natural that I want to know all about my competitor.

It is really very annoying that we are unable to discuss matters orally for only a few days.

Good bye dear Sir.

With an affectionate handshake, I am

Your devoted

Mouillard

I thank you very much for the article. I received the 15 copies of the Cosmopolitan. I hoped they would photograph my drawings, but they copied them. It is hard to make a drawing of a bird. My drawings have a quality which makes the subject come to life; they were arranged this way. The artist who copied them has spoiled a good number of them, especially those over which he was in a quandray.

April 24, 1894

Mr. L. P. Mouillard

Dear Sir,

I received your letters of March 23 and 30. Mr. Scott is back home. He told me that he did not get but one of your cards at the hotel and no letter at all. As he only had the address I gave him "Rue de l'Eglise Catholique," he set out with his dragoman to look you up. They got to an approximately square kind of a section where they asked for you from door to door without success. Then Mr. Scott left and sent the dragoman back alone to renew the search, but without any better results. He did not do what I told him to do, to send you a letter by mail and arrange for a meeting. So, at his great regret he missed seeing you.

Since this chance to form a group did not materialize, I am willing to do myself what I am able to do. I guarantee you the amount of 2500 francs which you estimated for the first machine, and to relieve you from anxiety an additional similar amount if necessary. At present I am unable to promise you to go beyond this, because of the state of my personal affairs. I shall send you the first 2500 within a month.

Please read once more what Lilienthal has to say about the hazard with machines which are too large. He started out with a 10 meter span and had to reduce to 7 meters. I am sending you a sketch I made so I might get an idea of Lilienthal's design; it comes pretty close to it. At present he builds a machine equipped with a 2 h.p. steam engine. This engine is installed only to actuate the wing tips, and we hardly shall know the results before next summer.

The Smithsonian which has the translation of "L'Empire de l'Air" has been published. I think Mr. Langley is going to send it to you.

I received two letters from people who read your article in the Cosmopolitan. These letters were addressed to this magazine for more detailed information. I answered both of them.

With a sincere handshake I am

O. Chanute

Cairo
May 18, 1894

Mr. O. Chanute, Engineer
Chicago

My dear sir,

I received your very good letter of April 24. I thank you infinitely for your kindness to me. So I will be able to produce something other than phrases.

It is a test airplane, that is understood, but in spite of that my objective is to produce a course of flight with an average wind that I will choose of about 5 meters. This word "course" includes the ascension, the penetration, the complete flight less the difficulties that are the very strong winds to which I will not expose myself with this apparatus, which couldn't with the existing mechanism resist those, for the variations of the center of gravity and of the surface will not be accentuated enough to permit it. I only wish to do the first hours of flight, once propelled, carrying well on the air, possessing well his skill as a bird as I possess it, in a comfortable position. (I am astride.) I believe that after a few experiments to get used to the sensation of the empty space one can stay long in the air. To be stationed in the air is to be moving; it is covering much distance unless one practices the parachute which I am not going to do. In order to prevent falling, in order to make it impossible, I intend to leave from the flat ground slightly inclined. It is probable that by the single action of the velocipede, the incline helping somewhat, I will attain a speed of 5 meters per second against a wind of 5 meters per second. That doesn't seem exaggerated to me. In that case this running against the wind, the wings full at the back, if at the moment of the greatest speed I bring the points in front I must be carried by the air like the birds are carried. Once in full support, it is my knowledge of flight that must inspire me. It is for this that, although I shall be assisted by young and active friends, I will not let them try this machine because I am conscious that they don't know and that the occurrence of wind or of unbalance would catch them by surprise and would be very dangerous.

To get used to this strange movement I wish to practice first the speed at a very low height from 10 to 20 meters and to begin to climb by means of spirals only much later, after being convinced to have done it against the wind directly like the pendion fluviales. In the desert I shall meet all these conditions I wish for, and above all solitude.

If I act progressively and prudently I believe there is no danger.

Let me shake your hand most heartily

Your devoted
Mouillard

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May 24, 1894

Mr. L. P. Mouillard

My dear sir,

I just returned from Denver (close to the Rocky Mountains) where I suffered the loss of the oldest of my grandchildren, a 10 year old boy who gave hope to great intelligence.

On my return I found your kind letter of April 20 and I am enclosing herewith 2500 francs for your experiments. I only ask you for two things: 1) To send me drawings and descriptions of your machines as the work progresses. 2) To keep me posted of your results.

I asked an aluminum manufacturer to send you samples of his products and to write me a letter for you which I shall translate and mail to you. Here are the answers to your questions: 1) I told you not to depend on rockets because they do not always push straight; the slightest imperfection in the tube makes them deviate; this happens so fast that there is no time to adjust the carrying surfaces. Rather make use of gravity and especially take off from the top of a hill, the same as Lilienthal, in order to get into an ascending current. 2) On April 27 I mailed you some sketches showing Lilienthal's machine. I enclose in this letter a translation of a letter I received from his brother. In "Aeronautics" you may note an English translation of his complete article and I am going to translate for you those parts which have been omitted or poorly interpreted in "L'Aeronaute" which I believe you get regularly.

I am sending you a write-up of an English paper on your article in the Cosmopolitan.

My own articles, which I sent you, attracted some interest and have been reprinted in book form, of which I am sending you a copy. At present I am taking a rest and I do not want at all to apply myself so continually to aviation for fear to become erratic over this subject. Yet I had an idea, different than yours, which I intend to try out; but this will be left for later on when I am my old self again.

Very truly yours,

O. Chanute

See in my book on page 263 where I indicate as the best way to experiment is to use the idea of LeBris and leave from a steamer going against the wind.

Berlin
May 5, 1894

Mr. O. Chanute
Chicago

Dear Sir,

As my brother, Mr. Otto Lilienthal, does not write English, I kindly ask you to accept my answer to your friendly letter of March 12.

We are pleased to learn that with the purchase of my brother's book "Der Vogelflug" you are ready to study our experiments.

Indeed we would like to see them repeated on a larger scale by somebody who has greater resources at his disposal.

Our means for the experiments are very limited and we even have less spare time to be devoted to this diversion. Contrary to what has been published in certain foreign papers, we have not received the least assistance from any branch of the government whatever.

The Emperor's recent gift to the Aeronautical Society has been used to purchase the balloon "Thoemi" as a replacement of the balloon "Humboldt" which was destroyed by fire.

Our experiments with fixed wings have been discontinued and flapping wings will be substituted. We started out with the latter type, but had to stop, because shape and equilibrium had not been sufficiently investigated. The latter difficulty has been overcome, so that we now can try flapping wings again.

There is a hard road to be traveled, but we do not follow it without some guidance, although we would be pleased to have more than what our own studies have provided.

We shall be very glad to see the publication of your investigations, and we note with great pleasure that you are going to send us a copy.

Very sincerely yours,

(Signed) G. Lilienthal

May 25, 1894

P.S. Mr. Mouillard - I received a letter from Mr. Whittlessey. The examiner has changed his absurd viewpoint in regard to your patent, but now he raises objections against claims 1, 2, 3, 4, 9, 17, 18, 15, 16, 19, 22, 23, 24. Mr. Whittlessey asks for my suggestions. I believe I have to go to Washington to fight, as I did when I went there previously.

See the article in the April issue of "Aeronautics" page 86: "The Attitude of the Patent Office Towards Flying Machine Invention."

O. Chanute

Chicago
June 2, 1894

Mr. L. P. Mouillard
Dear Sir,

I wrote you on May 24, enclosing in the letter 2500 francs for your experiments.

Today I mail you the translation of the parts omitted from Lilienthal's article which was published in the January number of L'Aeronaute. It would be interesting to you if you read both together, to give you an idea of the true purpose of this article. You will note that Lilienthal openly invited amateurs to make experiments similar to his, without however divulging the construction details of his machine.

When I received the drawings of your patent, I believe I wrote you that you will not be able to glide with flat surfaces and without a starting run. These were theoretical views, but they are fully confirmed by what Lilienthal has to say.

From Mr. Whittlessey I got the details and the chicanery put up by the Patent Office. I am going to answer him and later on I shall go to Washington myself.

Very truly yours,

O. Chanute

Cairo
June 13, 1894

Mr. O. Chanute, Engineer
Chicago

My dear sir,

An hour ago I received your kind letter. Knowing that you are worried about the punctuality of our mail delivery, I hasten to acknowledge receipt of your draft of 2500 francs on the Credit Lyonnais in Cairo and wish to thank you for it from the bottom of my heart.

I also received your book "Progress in Flying Machines." I glanced through it, and by means of the table and the illustrations I could form an opinion about it. I wish to express my very sincere compliments to you. It seems to me that it is a complete historical account of the problem up to date. It is unfortunate for me that I am so ill-adapted to the study of languages. I have started to study English twenty times, and twenty times I had to give up, which proves that I have not the slightest talent for languages.

You asked me to keep you posted on the way the money is used with which you so kindly entrusted me. I had in mind to do the very same thing and you may rest assured that I shall not fail you; that is the least I can do. In this connection and in reference to the aluminum manufacturer will you please find out whether what I read in "L'Année Scientifique" of 1894 is correct. According to this annual the Pittsburgh Reduction Co. of Pittsburgh are actually making a new aluminum alloy - aluminum and titanium which it seems ought to become of great industrial importance. According to Professor S. P. Langley this alloy has considerable strength, etc. This may then be the alloy Mr. Langley used for his machine - a type of aluminum which would have the strength and elasticity of steel. I was looking for such a material at Lyons but it has not yet been developed there. If the statement about the Pittsburgh firm is true please have them send me some samples of their product to enable me to form an opinion of its strength. I believe this is the material I am looking for because plain aluminum seems to be too soft. Mr. Hureau de Villeneuve whom I asked for addresses of manufacturers of aluminum tells me that this metal is not durable; he ought to change his view on the above alloy. It has to be seen and studied. Will you please excuse me for asking you to do me this favor; kindly blame it on my ignorance of the English language. Continuing with the reply to your letter, I wish to say that I shall put the rocket in a rigid iron pipe which will correct the direction in case the rocket should burn sideways. I am going to build an airplane equipped with bicycle. For the take-off run I shall have the action of my legs of which I do not expect much on level ground; but I will have to make use of it going down an incline to increase the speed. Once I know how to fly, when I have familiarized myself with the empty space,

the rocket will be used as an emergency as this certainly will be the quicker way to get into action again especially when I am unable to land on an incline. I consider a steamship to be 'very good. However, in order to make use of it we need a seaplane and a steamboat. Let us postpone it until some other time.

It must be very very hard to see a grandchild pass away. As I never had any children I do not know this grief, but I can well understand it. Permit me, dear Sir, to share yours.

With an affectionate handshake I am

Your very devoted

Mouillard

June 15, 1894

Mr. L. P. Mouillard

Dear Sir,

I received your kind letter of May 18. The plan you have laid out for your experiments seems very wise and well conceived.

Regarding the construction of the machine. Some time ago you asked me to send you a sample of a sheet of the alloy steel and aluminum. But as this alloy did not give the expected results I had to wait for new experiments.

I am sending you a sample of nickel-aluminum alloy. This alloy has been perfected so recently that it is not even described in the manufacturer's catalog. I am sending you this catalog as well as a letter he wrote me, and its translation.

You know that up to now aluminum has not yet taken the place of steel. True, it weighs less, but it also is less strong. Furthermore the weight necessary to resist a certain load would be about the same as that of steel. Alloyed with nickel, aluminum surpasses steel, but in a very small proportion, as you will see in the company's letter.

If you should decide to make use of this metal I could send you the panels you need. But I tell you frankly, that for an experimental airplane which is certain to be remodeled time and again, I would use bamboo which you should find excellent.

In order to do this, I would superpose the wings at a distance equal to their width. In this case they would not affect one another. I also would connect them together by means of St. Andrew's crosses. This is the idea which I mentioned to you in one of my letters.

If you have somebody who understands English let him explain to you the aluminum catalog. It contains the most recent developments in industry.

I wish you good luck, and with a cordial handshake I am

O. Chanute

Original of a Letter from the Pittsburgh Reduction Co.
(Chanute translated into French and sent to Mouillard.)

Pittsburgh
May 31, 1894

Mr. Octave Chanute
413 E. Huron St.
Chicago, Illinois

Dear Sir,

For your information and that of your friend Mr. L. P. Mouillard, Rue de l'Eglise Catholique, Cairo, Egypt, I have the pleasure of sending you a copy of the catalog of the Pittsburgh Reduction Co. I also mailed you a sample of laminated hard aluminum. This is in angular form, and shows the way it may be soldered.

Pure aluminum, in sheets or in bars, has a tensile strength of from 14.06 to 17.57 kilograms per square millimeter and a limit of elasticity of about 50 percent of that of fatigue fracture.

The tough alloy which we call Nickel Aluminum has a specific weight of from 2.8 to 2.9 in laminated bars, and a tensile strength of 28.12 to 35.14 kilograms per square millimeter.

Pure aluminum will withstand a pull of at least 2.1 kilograms per square millimeter, while with Nickel Aluminum this load is increased to from 4.2 to 5.62 kilograms per square millimeter. For compression and transversal loads we could furnish a very rigid and tough metal which has approximately the strength of iron; however this is an alloy which contains only 75 percent aluminum, the rest are other metals. This is a cast metal; as a laminated metal, Nickel Aluminum is very rigid. In this direction we could demonstrate that when a hole of a diameter of 19 millimeters is bored in a sheet which is 6 millimeters thick, this hole may be enlarged to a diameter of 50 millimeters by hammering a conical tool into it without splitting or fracturing the sheet.

We also have tested Nickel Aluminum in regard to its bending strength and established the fact that it is not inflected more than steel whose strength is 46 kilograms per square millimeter at the breaking point.

We shall be glad to give you any other information if you so desire.

Respectfully
The Pittsburgh Reduction Co.

P.S. by Chanute: In another letter this company states that they could furnish aluminum (in quantity) at a price of 5 francs per kilogram for cast metal, to which is added to cost for rolling which varies slightly for sheets, bars, angles, and other sections necessary. See page 14 of the catalog.

July 5, 1894

Mr. L. P. Mouillard

Dear Sir,

I received your letter of June 13, and mine of the 15 (I also wrote on the 2nd) should have given you the information on aluminum you requested.

The weak point of this metal, even with nickel as an alloy, is its resistance to compression, and consequently to the transversal load which causes traction on the lower edge and compression on the upper edge. This is the reason why the Pittsburgh Reduction Co. gives a load of 4.2 to 5.62 kilograms per square millimeter, while a load of 10.59 kilos per square millimeter is carried readily by steel used for bridge building. I have no data at all on bamboo, but I note on page 100 of l'Aeronaute of 1875, that Penaud found out that "reed fibres of various density, but of 0.7 as an average, have a strength, also on an average, of about 19 kilos per square millimeter."

The density of the reed is therefore $\frac{0.7}{2.8} = \frac{1}{4}$ of the density of aluminum, and as it has a tensile strength of 19 kilos per square millimeter; the same weight as that of aluminum should have a resistance of $19 \times 4 = 76$ kilos per square millimeter instead of 29.12 to 35.14 as given for aluminum. Therefore, the reed fibre, at the same weight, has a greater tensile strength than aluminum. Moreover, you will find in the March 1894 issue of Aeronautics the results of Prof. Thurston's investigation on aeronautical construction materials and the ensuing discussion. The best woods weigh about 1/10 less than steel and are about 1/5 as strong. Therefore, the weight being equal, they are stronger but they deteriorate quicker.

In case you make some preliminary experiments to determine the strength of wood or bamboo you have at your disposal, please inform me of the results. Facts to observe are as follows:

Species - condition - thickness, or weight per square millimeter
 Tensile strength per square millimeter
 Compression strength per square millimeter and proportion of length and lower part
 Transversal load strength, giving 1) diameter, 2) space between supports, 3) weights that cause fracture, 4) degree of bending before fracture.

With a handshake, I am

O. Chanute

Cairo
July 13, 1894

Mr. O. Chanute, Engineer
Chicago

My Dear Sir,

Have you ever had the experience that you thought to be ready to get things going, or only to make some drawings, and then discover that there are many points which have to be specified first, and many details which you have forgotten? That is just the position in which I find myself. I designed on paper, in full scale, and I want to tell you that this is not an easy matter. Then, as it will be I who has to make the experiments, I put myself under a serious examination about every maneuver it will be necessary for me to make; and to check on them, I watched how my neighbors, the kites do them. At this point I wonder how those who have no models will be able to succeed.

Having examined everything, I am well pleased with the result. There remains nothing to be done except to start building. There again your kind letter and especially the sample you enclosed have completely dispelled my ideas on aluminum. That is not at all what I am looking for. This metal is nothing but light lead; what I need is a strong and elastic steel. So let us forget the aluminum. Bamboo is in this way quite adaptable to replace this metal. Bamboo has its faults, but I have handled it for a long time and the problem will be to get around the difficulty. Therefore, I have to reconstruct the wings in my mind. This will be quickly done.

I do not plan to begin building before September because of a malady you do not know which manifests itself as a inertia of body and mind. The excessive heat is the cause of it. This year we have been hard hit. During most of the entire month of June we had 45° C. at 3 p.m. and 35° C. at daybreak, supposed to be the coolest time of the day. The heat reached even 47° C. and I would not want you to be exposed to such a temperature for such a length of time. As soon as perspiration stops, as there is no more cooling, there is mortal danger because of overheating of the blood. Also, I vowed to do what is possible, and appears like the impossible, not to spend another summer in Egypt.

I received the draft you sent me, and as I have no use for the money at present, I deposited it to my account with the Credit Lyonnais. In this way my mind is more at ease.

Dear sir, I remain with a cordial handshake,

Your very devoted

Mouillard

As soon as I have the design made, I shall send you a tracing.

Cairo
July 21, 1894

Mr. O. Chanute, Engineer
Chicago

My dear sir,

I have already answered your recent letter (June 15), telling you that I have given up the idea of using aluminum. However, after careful consideration I have to take up this matter once more.

I received some more samples from Paris and from Marseille, which are even less fit for my purpose than the sample of the Pittsburgh Reduction Co. you sent me. The best of them is so brittle that it cracks when it is bent.

What I would like to get is a sample of about 0.15 x 0.10, the size of an ordinary sheet of writing paper, and to be about 0.0025 thick of the same metal of which you sent me a sample. Then another sample of the same size of an alloy which is stronger and stiffer, if they have it. Finally I want you to let me have the address of this company so I shall not always have to trouble you to write to them. I hope they understand French.

I want this thickness and this surface because this is the thickness I wish to use for the framework of the wings and for the fabric, so that I may be able to attach the plate well and to get a good opinion of its resistance.

I am always more and more determined to do the impossible, in order not to spend the next summer in Cairo. This is the hottest summer I have experienced since 1865.

With a cordial handshake, I am

Your very devoted

Mouillard

I did not understand the last part of your letter which deals with the use of the St. Andrew cross. Are these the superposed airplanes? If so, I can only use them on the wing tips because of the requirements of control. Please give me a more lengthy explanation of this matter in your next letter.

July 31, 1894

Mr. L. P. Mouillard

My Dear Sir,

I have just received your kind letter of the 13th and I am convinced that you chose wisely when you decided to use the bamboo as I recommended to you in mine of June 5.

I feel sorry for the heat that you have to endure. We have had 37° C. here for several days, but the temperature has gone back to 26° C. since.

We received a dispatch from Brussels a few days ago announcing that Sunday, July 22, Lilienthal's wings had folded one on top of the other, the same as for your accident on your page 248 and that he has been precipitated from a height of about 30 meters, the fall having been softened, but Lilienthal badly hurt.

A dispatch from Berlin of the 25th tells us that there is nothing to it, that indeed there has been a slight fall, but that Lilienthal is not hurt, and that his machine has been only slightly damaged. I am sending you the London message which confirms that from Berlin.

Still I want to urge you again to make your experiments above the water if possible. See what I told you.

I still believe that an accident will happen to Lilienthal this summer and in this case it will be up to you to solve the problem of aviation.

I see in the Aeronaute that in April Jobert proposed a machine with the aim of making experiments like those of Lilienthal, and that since then Mr. Pouchet ^{Pouchet} also offered to repeat these experiments. Also that a man from Dartmouth (England) called Liewenthal has constructed a plane according to your theories. This latter plane seems much too big for me, and subjected to being thrown over by the inequalities of the pressure of the wind.

I don't hear anything being said about American experiments, and I haven't heard yet anything from Mr. Whittlesey, who has sent new observations to the Patent Bureau in order to obtain your demands. I do not press him because your interests are covered for America.

Sincerely

O. Chanute

August 15, 1894

Mr. L. P. Mouillard

Dear Sir,

I received your letter of July 21. I wrote to Pittsburgh for the samples of aluminum and I'll send them to you as soon as I get them.

You must have received my letter of July 5 in which I make the comparison of bamboo with aluminum and of wood with steel, comparison which brings out the inferiority of metal for light construction. Since then I have examined the result of tests of bamboo in compression which indicate that it is superior, at equal weight to the metallic tubes, if one has selected the bamboo but that there are enormous differences if one does not select it carefully. I am more and more convinced that the bamboo is preferable for you to the aluminum. It is also the solution that Lilienthal adopted when he constructed with bamboo.

Regarding the superposed planes that I proposed to you I don't see how they can interfere with the direction. I thought that the plan of the airplane would be the same, as shown here, and that the principal arms would alone be made

Plan seen from below.

against the wind, whether you place them diagonally, or on the forward edges, as I would prefer.

Elevation seen from front.

The arms of the upper wings would be linked to the lower by bamboo vertical stems, *a a*, and pullers, *b b*, forming St. Andrew crosses but this resistance to the wind would not be carried to the end so that the flexible part of the wings could rise under the pressure of the wind, in *c c*, and add to its stability. The rearward edges of the wings, *d d*, would also be flexible, like those of the birds and would rise up under pressure or from the speed, that would not hinder in any way the steering because you can either move forward or backward the ends of the wings on the central pivot and let the directing planes act on the rear section of the wings, while you would have a rigid construction of the arms which would diminish by half the spread and consequently the weight of $\frac{3}{4}$. The two series of wings must be separated one from the other at a distance at least equal to their breadth.

Sincerely
O. Chanute

Cairo
September 21, 1894

Mr. O. Chanute, Engineer
Chicago

Very dear sir:

I received your kind letter and two samples of al.
(If you permit, we shall abbreviate this long word by using al which is so much shorter.)

I tried these two samples and I find that they do very well for me. I received about 10 others from European factories but they are far from being as good as those from Pittsburgh. As they are they will be all right. So please ask them for:

- 1) a sheet of 1 meter long and 4.25 m. long and 0.0025 thickness - similar to the sample that you sent me. It is the one that is rigid, blue in color (at the factory they must be able to recognize it); there will be no error. (It is to make the framework of the wings.)
- 2) A sheet of 0.75 to 1 m. of soft al of 0.0025 - it is the one that bends under the pressure of the hand; it is white, slightly yellowish, like silver. I want to use that one to make strong connections. No. 1, the rigid one, cannot be bent by hand in the shape of the sample whereas the soft one is easily shaped by tightening your hold a little.
- 3) Two square meters of al, soft, of 0.001 thickness.
- 4) Wires of soft al - 10 m of .002 in diameter to make rivets
50 m of .0015 in diameter
100 m of .001 in diameter to fasten the net of the wings.
- 5) Weldings or their formulas for these two kinds of al, 2 kg of each and some explanation of the way to use them (so that one has not to look for it).

I attach to the present a check on the Credit Lyonnaise to your order of 250 fr which seems to me about to the amount of the bill according to the price of 5 fr that you indicated to me at your first shipment (the sample of welding).

When it has been constructed I will take one single photograph and send it to you. I am not very much afraid of indiscretions for I am convinced that the real safeguard of this apparatus is "the knowledge of flight."

The temperature has decreased a great deal. We have from 25 - 35° C. I am getting over the effects of this terrible summer weather. I hope to be in good health this winter to try the experiments. I am well for the season.

Please pardon me if I speak to you about my health, but I believe it is an important factor for our success.

Mouillard

October 10, 1894

Mr. L. P. Mouillard

Dear Sir,

I received last night your letter of September 21 and have just sent your check and your order to the Pittsburgh Reduction Company. I am very happy to hear that your health is good and I wish you the best of success.

I should prefer very much that you send me blueprints of your plans and sketches rather than a photo. One doesn't understand much from photos, as witness those of Lilienthal.

I just received a letter from Whittlesey of the 8th. The patent bureau refuses our 1. - 23 and 24 demand (see your copy in the translation of July 24, 1892). The other claims are accepted, after much chicanery of which I told you in my letters and for which we changed a word now and then, still taking care of all your interests.

As I wrote you some time ago, I doubt if I can obtain such wide claims, but Mr. Whittlesey proposes to appeal to the chief examiner and I sent him 100 frs for expenses. I suppose that I will have to go to Washington to plead your cause before the chief examiners and I'll let you know the results.

Regarding the lubricator, we are at the end of our rope. The Bureau has enumerated a good number of American and English patents which propose different systems of pipes to lubricate the keel of the boats. We have been obliged to fall back on the system which consists in emitting an emulsion of sea water and any kind of oil for that effect and now the Bureau tells us about the English patent of Richard Hurot, No. 14747 of 1890 that describes a system to apply an emulsion of water and oil through pipes placed on the keel of the boats. Whittlesey thinks that we should abandon our claim; and here are 250 francs gone over the dam that has not been lubricated.

Lilienthal sent the plans of his machine to two American engineers, one in New York and the other in Massachusetts. The first constructed a machine 6 meters wide, weighing 12 kg and used it with success. He gave me the details of it. I am not yet corresponding with the other one.

Yours

O. Chanute

Cairo
November 2, 1894

My dear Sir,

I received your kind letter of October 18 and I see there all the troubles that you have with these patents. I cannot be of any use to you in that affair and I confess that I think of nothing else than the airplane. From the day that I get the aluminum from Pittsburgh I will be in the midst of constructing. The threading is finished for 10 cm of screw. I think that the whole will be finished by the end of January and that at that time I will be able to try it out. I am certain that something will come out of these experiments. What? It is very daring to conjecture; it would be selling the hide of the bear before killing him. But certainly there will be news.

Referring to that, I wish you would tell me that you are coming to Cairo this winter. I should be happy to see you watching these tryouts. If, unfortunately for me, you cannot, you may be sure that I'll keep you informed of each experiment and that at the first serious flight I will send you a wire to come - before disappearing from this world to continue my studies and to perfect myself in the flight - that will give time to the gentlemen delivering the patents to think it over and to form an opinion.

I asked you some time ago to look for a money-making use of this flying machine. Having my mind absorbed by the construction, I haven't found a new source of income. You have perhaps been luckier than I and I beg you to tell me what you discovered.

I would not like to play the clown or be a smuggler; in short, I would not do anything improper. I certainly would like wealth, but honestly obtained, money of which one can be proud.

I am still on that question; I am thinking of using the airplane for the following uses:

- (1) With my knowledge of geology and minerology, to hunt for precious metals in inaccessible places; those places where one man alone can do a lot of work in a short time.
- (2) The hunting of whales (cetaces) would seem to be lucrative even in seas where they are not hunted on account of their scarcity. This apparatus would enormously facilitate their search and would make their escape nearly impossible.
- (3) And last, if I am able to construct this big machine, I will realize my last whim in Mr. O. Chanute's company in a journey to the North Pole. I believe that the publication of an account of this journey would be a money-making project.

If you can send me details of Lilienthal's glider (sent to the two Americans), especially the one of 6-meter width and 12-kilograms weight, you would afford me great pleasure.

In conclusion, I can only say that I am in a state of mind to dare a great deal.

Goodbye, dear Sir, affectionately and devotedly

Mouillard

The least success would greatly help the success of all the other questions.

Chicago
November 21, 1894

Dear Sir,

Your kind letter of November 2 arrived at the moment when I was worrying about you. The Pittsburgh Reduction Company accepted your order and we exchanged one or two letters concerning the official documents to the Egyptian government for sending the parcel. Not hearing that the shipment had taken place, I wrote to the Company the 12th and I am sending you the translation of my reply.

It seems that you have ordered larger sheets than those used up to now in the business and that the Company is puzzled.

I answered them that I believed that the large sheet would be divided in two, but that I didn't know if this division would be made on the transverse or the diagonal, that I believed the latter case to be the right one, that the other sheet could be a

little narrower and a little longer, but that because it would take many days before getting an answer from Cairo, I begged them to reconsider the difficulties and to let me know if they could not be overcome. I have no answer yet and I just wrote again. I hate to change your instructions, but I know how important it is to make the shipment as quickly as possible. I'll write you again as soon as I have an answer from the Company.

Sincerely

O. Chanute

Chicago
November 2, 1894

Dear Sir,

In answer to your question about the lucrative uses of your machine, if it succeeds, it always seemed to me that profit would consist in selling the machine either to the Government (especially in Europe where war is imminent) or to the fans who want novelty.

For that, one should patent everything that cannot be kept a secret, and organize a company for these patents. It is always the producer who gets the benefit of an invention, but it is very possible that by turning these patents into business shares, one could sell these shares at a good price before even many machines are sold. If there are clients who will use these machines to discover mines otherwise inaccessible, for the hunting of the big whales, or for a journey to the North Pole, so much the better - that will bring other buyers, but you have all your time taken up in improving your machine, in taking care of your interests, and in instructing the professors who must instruct the buyers.

The appeal for your patent has been discussed before the chief examiners the 15th of last month. The decision has not been announced yet. I couldn't go to Washington on account of engagements here, but I reviewed the brief of Whittlesey and I sent him some notes. I think that we will obtain all that is important.

I wrote Mr. Whittlesey to put the patent into the secret archives. That gives us six months for a patent in Europe and I want you to let me know what you think should be done in this regard. The European patents will cost about 10,000 francs. One can economize this sum by taking only the most important countries, but one is open to the competition of the makers in other countries, and somebody buying a plane in Sweden, for example, could use it in France.

I wish very much to come and see you in Cairo, first to see your experiments, then to discuss the financial questions, but I am afraid I cannot do it this winter. My wife doesn't want to make the voyage. Her sister is going to Mexico for the winter and she wants to go there too. In that case I'll go with her, because her health is not at all good.

Wishing to answer you at once to tell you how your order for aluminum stands, I have to postpone to a later date the translation of the information that I have on the American machine of 6 m. width and 12 kg. weight. It has just been broken by a gust of wind, but the maker is constructing another one that he thinks will be better.

Affectionately, Devotedly

O. Chanute

Cairo
November 25, 1894

Very dear Sir,

I have no news of the aluminum. Your kind last letter informs me of your sending the draft to Pittsburgh on October 10. That is a month and a half ago and still nothing is in sight. I am beginning to get worried. However, since Pittsburgh is not next door and as the stuff is probably coming by slow conveyance, it may be that all that time is necessary.

I am taking advantage of a month's vacation that I have to do some building. I have ordered all the iron parts and the under-carriage wheels. I expect a good deal will be finished by about the fifteenth.

My health is excellent. I am doing exercises to get myself into action again; but I am not twenty any more; these poor missing muscles are a rusty old man's; I am finding out quite a few places where some should be. Nevertheless, the aggregate is almost satisfactory. I catch myself climbing the stairs two at a time and running, which gives me an appetite such as I have not had in a very long time. In short, I expect that the extensors and flexors will be adequate to provide that demonstration.

Am I to have the pleasure of seeing you in Cairo this winter?

Did you read in the Aeronaute of November an article on the machine of Hiram Maxim, by M. Francois Colas? I think quite as M. Colas does; only he forgot something — to ask him how he will manage the landing, for to run along the ground with railroad train wheels is not to be thought of. Which permits one to confirm that though Maxim is a very fine mechanic, he is a wretched aviator.

I hope, dear Sir, that you are well, that all your family are in perfect health, and that your business is going agreeably to your wishes.

I clasp your hand most affectionately and am your entirely devoted

Mouillard

November 29, 1894

M. Mouillard

Dear Sir,

The examiner is beaten, and we obtain our patent. Not quite absolute, not all what we have given, but almost everything that is useful. The claims that have not been accepted by the chief examiner are the No. 1, 9, 22, 23, 24 of the specifications that I sent you July 25, 1892. You'll see that the 19 that have passed will protect your machine adequately.

I believe that the Maxim quarrel has been useful to us. You'll see in November's "l'Aeronaute" that he gave the examiner who told him the same silly tales as he did to you "that he couldn't rise without a balloon" a piece of his mind.

I wrote Mr. Whittlesey to put the patent into the secret archives, and I asked him to give me information about European patents.

I have a letter from the Pittsburgh Reduction Company that they arranged to laminate a sheet one meter wide as you asked and the shipment will soon be made.

I'll write you in a few days concerning the airplane of 6m in width.

Sincerely,

O. Chanute

Cairo
December 11, 1894

Mr. O. Chanute

My Dear Sir,

I answer your letter of November 14th.

Here is how we get around the difficulty. I want:
two sheets of rigid aluminum of 0.0025 thickness and in each
one length 4.25 m. and width of the large side 0.42, at the
small side 0.26, figure 1. (p. 196)

Plus two other sheets, also of the same rigid aluminum
the same thickness, each 4.25 m., length 0.08 wide on one side
and 0.06 on the other, figure 2. (p. 196)

The sheet of soft aluminum for which I asked can change
shape without inconvenience; if it is 0.50 wide that is enough.

The rest of the order doesn't change.

I hope that the factory will not be inconvenienced by the
size of the sheets or the size of the ingots. I would be very
worried if the length would be too great. If through bad luck
that would happen they would have to be cut in two, much as I
regret it. I would be forced to resort to a seam with rivets
or to welding which in itself would be a constant source of
trouble for me, because I would always be afraid that the metal
beam would break at this point. But as the translation of the
letter to the Pittsburgh Company doesn't say anything about it,
I hope it will not happen.

I will finish the "bicycle" so that there will be only the
wings left to be done, which, once the aluminum has arrived, will
not take long.

As for the mode of transportation for this box I believe
it would be best to put it on a steamer for Alexandria or for
the Suez Canal which would leave it at Port Said with my address
in Cairo. The agent who would receive it there would send it to
me after it is put through the Customs and I would get it; that
would be quicker and less expensive than sending it by way of
England and France.

I forgot a sheet of rigid aluminum to make tubes, which I
cannot get ready made on account of the wrapping. This rectangular
sheet would be 4.25 by 0.40 m.

Another idea to utilize this machine has been suggested to me. It is the exploitation of wood in high plateaus that cannot be reached in very mountainous country.

Now let me tell you that I am grieving to know that I will not have the pleasure of seeing you this winter. But at the first interesting development you may be sure that I will ask for your presence. Please give my regards to Madame Chanute with my wishes for her recovery and you, dear Sir, accept a handshake of your devoted

Mouillard

When you are in Mexico, try look out for a way to see the Larcorampe which is not rare in that country; you would have under your eyes a beautiful model of gliding flight. I believe that you have to go out in the country and attract it with dead animals.

These two drawings are not on a scale; it is only to indicate the shape of these sheets.

Cairo
December 20, 1894

My Dear Sir,

I received last night your kind letter of November 29 that gives me much pleasure. Mr. Maxim has shown the way and the examiner is obliged to be more prudent which has been our good luck. One must pardon him, for this new field is not part of his knowledge. All's well that ends well.

The patent, excellent as it is, is little compared to the execution; there remains the flight. As I have an ardent faith, as I am conscious of knowing how to fly, and finally since it is the last important act of my life, I'll try, in cold blood, to be able to face this problem. So to you the patent, the commercial transactions of which I know nothing, and to me the flight.

It's useless to say again that all you have done is well done. We know each other well enough now I think so that we have no doubts about each other. For me it is like that.

I have a screw that turned out all right; I believe that it will work well. The two wheels are too heavy. I'll try them anyhow the way they are, ready to make them lighter or to change them if it is necessary. I found some excellent bamboo. As to my health, I feel better than I have in a long time; it's not surprising, we have at 10 a.m. 10° C. Such a temperature is good for invigorating a body weakened by the Egyptian summer.

Now, my dear Sir, allow me to wish a happy New Year to you and all of yours

Yours devotedly

Mouillard

December 22, 1894

Mr. Mouillard

Dear Sir,

I received your letter of November 25th and I have again been after your manufacturers of aluminum. I send you by same mail the translation of their answer, and I wrote them again. You must have received letters of 21 and 29 of November explaining to you the cause of this delay which has given me much trouble. I hope that you will have your aluminum in Cairo between the 20 - 30 of January but I can't give you a guarantee.

I also send you the details I promised you about the 6 m. airplane. They were spread over different letters that spoke about other subjects.

I cannot tell you how happy I am to know that your health is so blooming. That will contribute a great deal to your success, for Lilienthal and all his imitators complain about the gymnastics necessary for aviation.

I wish you good luck and a happy new year.

O. Chanute

January 4, 1895

Mr. L. P. Mouillard

Dear Sir,

I received your kind letter of December 11 on the 25. I wrote immediately to the Pittsburgh Company and I just received their answer. Your modification came too late and the order was just filled. They will add the extra sheet of hard aluminum that you asked for the tubes and the whole order will leave Pittsburgh today for New York.

I am leaving for New York tomorrow (I have other business there) to look after the shipment to Egypt and I'll write you from there. I don't know yet if the sheets will be flat or rolled.

I'm not going to Mexico. One of my wife's sisters died there suddenly and her brother-in-law came back very sick. I'll go with my wife to the South, but we have not yet decided about the place. I hope that there will be gliding birds there.

I sent you a blueprint proving that others have thought of the aerial velocipede and I shake your hands.

O. Chanute

Chicago
February 7, 1895

Mr. L. P. Mouillard

Dear Sir,

I find here your kind letter of December 20 on my return from New York, from where I wrote you two letters regarding your aluminum which must be in Genoa by now.

I stopped in Washington to consult Mr. Whittlesey and I found out that we are in better position regarding the European patents than I thought before. According to American law we still have an appeal to the General Commissioner from the decision of the Chief Examiners and we have two years for that, from November 24, 1894. Consequently, instead of putting the patent in the Secret Archives, which would give us only 6 months to take the European patents, I told Mr. Whittlesey to answer neither yes nor no to the decision of the chief examiners and to do nothing in Europe.

Now it is up to you to fly in a practical way before two years are over and according to your degree of success we will judge of the expense to be made in order to protect the invention in the different countries. I advise you to patent in France, in Germany, and in England, but I have my doubts about the other countries because it happens very rarely that an inventor at his first try has a machine so practical and sure that it will be copied at once. As you say very aptly, the essential thing is the doing; it still remains to fly.

Doubtless you are weighing continuously changes and improvements. Keep them secret (even from me if you want) so that you cannot be copied at once if you succeed. We will put them afterward in the European patents.

But you can show your machine to my friend Charles S. Smith in all confidence. He is an honorable man but he doesn't know what's on. I think he will be in Cairo around March 9.

During my stay in New York I spent a day with Colonel King, Chief of the Torpedo Station of the American Army at Millet's Point. I told him under secrecy the description and what is behind your torpedo. I wanted to know definitely what to think. He thinks that it is very ingenious but impracticable. He had mines exploding under water for me to see and he proved to me that the concussion propagates so far and so quickly across the water that the operator 50 meters away would certainly be killed. The fish are killed in great numbers. If the operator jumps from his torpedo farther than 50 meters the Colonel King thinks that he will miss his aim nine times out of ten, especially if the enemy boat is moving or if there are waves. He acknowledged the difficulties that must be overcome in letting go an electric torpedo just under

the surface with a chair on it occupied by a sailor; the smallest wave would make it deviate from the course.

He says there would be men who would risk it if there were five chances to ten to save one's life, but he thinks the first experiments would be the last ones with your machine.

Sincerely

O. Chanute

Chicago
February 3, 1895

Mr. L. P. Mouillard

Dear Sir,

Having made in New York the personal acquaintance of Mr. Herring, and having found him to be an engineer of great merit, very skillful with his hands, I decided to let him construct a machine of natural size to try out my idea. It is different from yours, of which I wrote to you in my letters, especially those of June 15 and August 16, 1894.

I am sending you under separate cover a blueprint of these drawings. The plan indicates 16 wings, each 1.8 m long and 0.7 m wide, superimposed two by two. The cut indicates the counter-winding, a St. Andrew's cross.

As I have told you, these wings are pivoted on the prolongation of the stems in steel in two frames 4.37 m in length and 25 mm in thickness, which are entirely covered with balloon linen, and thus form two vertical keels. They are inclined to the lower end 5° on the vertical, and the wings also form an angle of 5° each on the horizontal. That arrangement is to provide transverse equilibrium. The girders are louvered everywhere, except at space A, where the operator stands. He supports the machine with a strap passing over his shoulders at first, but once propelled he either keeps standing on small boards (running board) that are on each side, or he sits on a strap (see broken lines) and the girders are under his armpits. You can see that I borrowed from you the idea of the metal spring S,S,S,S for which an elastic rubber could be substituted t,t,t,t. If one uses the metallic spring, the adjustment would be made by the rods, R,R,R,R and all wings that are connected by the rods B,B,B so that a movement started by one pair of superimposed wings is transmitted to the whole system.

The manner of making the joints is shown in natural size and a second construction of wings is indicated below. The ribs are of bamboo, but the girders are of light wood with steel braces. The scale of the drawing is 2 feet = 1 inch, or 1/24th natural size. The curving of the front of the wings is obtained through the tension of a brass wire, which joins the tip end of the master bamboo with the first bamboo across (the one behind) and the two fit into a groove of metal through which the rod passes. This construction seems defective to me and I expect to modify it.

Mr. Herring will first make me a model 3/8th natural size, to make experiments in equilibrium and resistance with; and if these tests indicate an advantage over the Lilienthal system (which he has used up to now), we will proceed to building.

I have always believed that the system of multiple wings was worth experimenting with. I indicated this to you in one of my first letters, several years ago. I would be glad to get your criticism regarding the machine, primitive though it is, of which I am sending the drawing. The wings, naturally, are concave-convex and you will see that I imitate the cut of the forward edge of the wing of the glider, which I pointed out to you two years ago.

Very sincerely,

O. Chanute

Cairo
February 24, 1895

Mr. O. Chanute

My Dear Sir,

I have just received the box of aluminum in good condition. It seems to me that it is exactly what I requested only I believe that the aluminum wire will be insufficient; but as perfection does not come in this world I have to declare that I am satisfied. Now to work!

I hope that I will not weaken. As I will proceed progressively in the experiments, I believe that the obstacle of the free space below me will be relatively easy to conquer. I know the sensation from being up in a balloon, but I humbly confess that it is because I didn't dare to say "Stop"; finally I saw it and there frankly only the first step is difficult, the rest is easy. One feels more at home at 1000 m than at 100 m. I have strongly thought and studied during these times the down-to-earth question, that is, the money question. It is a horrible thing, but absolutely indispensable in order to do still better! I believe I have solved it through this machine, even as an airplane merely for demonstration. By this method the voyage to the Pole and the lessons to the aviators are put far behind. From the first kilometer accomplished I will need your financial knowledge and I will need you for ... but really, dear Sir, it is too much like selling the hide of the bear before having killed it. Still in spite of all I am happy to have solved this question of slight importance to my great satisfaction; it would have been extremely ridiculous not to be able to make use of one's first steps in aviation.

Tomorrow I'll begin with great speed the putting together of what has already been done with what still has to be done.

It is strange, but although it is a very dangerous problem, I have not the least apprehension of an accident.

I shake hands.

Very devotedly

Mouillard

Cairo
February 25, 1895

My Dear Sir,

So I am condemned to criticize your work. I submit to it only because you asked for it, but much against my wish. It is such a subtle matter, a criticism, that it takes nothing less but the remembrance of your kindness to me to make me do it. This implies therefore that what I am going to say is exactly what your very devoted friend is thinking.

Your description is not complete. I don't get from it whether you will construct a glider or a rower. It seems to me that it is this latter type that you want to reproduce. In that case I ask where is the motor?

I also ask you how one will get up a carrying speed.

It also seems to me that your model is the dragonfly and that you wish to do occasionally some gliding as this insect does at rare moments.

Starting from these thoughts I find that the displacement of the center of gravity which produces the vertical direction is not large enough for it is only equal to the displacement forward or backward of one single pair of wings and is not four times that of one pair of wings. So you must forcibly depend a great deal on the action of the tail. It will certainly act but only in the case of a strong wind if it is motionless or when the speed of the machine is sufficient.

Like everybody else, I too have looked at this interesting being, the dragonfly, with a great deal of curiosity; here is what I saw. First a flyer of absolutely infinitesimal size, very difficult to study, which by his small mass and his muscular resources poses at every instant problems of flight that one can only solve by attributing to his corneous (horny) muscles an activity which the long muscles of the big mammals can never produce. Look at her while she is in the act of chasing; there is where her faculties develop, which you certainly don't want to reproduce. But this act does indicate, however, her enormous power as a rower in the cases she has to overcome the difficulties of the long course flight, among others those given by a too active wind for her small size. She is very difficult to study in this case because owing to her small size and her transparency, she is at once out of sight.

What I have guessed rather than perfectly seen in this case is that she produces the vertical direction (which is according to my judgment the insufficient act in your machine) through an active forward shifting of the mass by bending back her abdomen, the heavy part of her being either below or above and making it at the same time do a directing action by scraping on the air as the tail of the bird does. The horizontal direction has not been

perceived by my weak human eyes and I don't believe either that other humans could have distinguished it. So one is forced to reconstruct it by thought. If I were a dragonfly I would use the torsion (twisting) of the wings to the side where I wanted to fly and the acceleration of the pair of wings to the opposite side, acts which are difficult to reproduce.

There is one point that I don't understand in the drawing. Your description speaks about sixteen wings and I only see eight. Let us assume for a moment just what I see - four pairs of wings. We will have a machine impracticable as for length, or built elongated on which are fastened eight or four pairs of wings. For a rower that may do, at least I hope so, but I must say that I find no precedent in nature to convince myself. As a glider nothing approaches this form.

The dragonfly is not made like that (for I believe that I'm not wrong in supposing that you copy this paradoxical model); the dragonfly is, when one looks at it from the viewpoint of aviation, shorter than she would seem at first. Her two pairs of wings are very close to each other; first difference with the system that you recommend. There she comes close to the bird with his one pair of wings; she gives the illusion of having two pairs, but without a great effort of thinking one can, owing to the closeness of these organs, consider them as linked to each other. Moreover, this great length of body is only fictitious, for we have just seen that it can be reduced and that she can even make use of it to direct herself.

It is probably this great necessary length of abdomen that made nature give her a great breadth of wing. As it was a great difficulty in construction, especially because it must be combined with a swiftness necessary to an animal living from the prey that she must catch in flight. Nature has split the wing and transformed the inactive outer wing into a nearly perfect wing. So I believe that I am right in saying that, from the viewpoint of an aviation mechanic, the dragonfly has only one pair of wings.

What kind of balance will be produced by this enormous length of your whole machine, whose ratio of length to width is less than $25\frac{1}{2}$ to 17? It is very hard to establish it mentally; I do not find out how one will keep up the horizontality of the ensemble except by giving it an activity in propulsion that will permit the action of the tail to become sufficient to keep it up at every moment. So this machine will become through this method of reasoning an excessive rower; it will produce gliding only after the acquired speed has been attained. Simple ascension is impossible on account of its shape, but it can be produced, even I believe with advantage, under the action of a light push.

While at rest, which means not projected to go, it becomes a parachute with undetermined falling habits, as for example a cigar balloon of which the propeller is stopped and which therefore has nothing left to keep it horizontal. It therefore lifts at random the front or the rear in the air as well as moving horizontally. This is in short what I think that this aviation machine will produce. Pushed by a strong enough propeller, having horizontal equilibrium by means of an angle of the wings slightly in V and a tail of action sufficient to produce vertical equilibrium, this machine will fly because it unites the two conditions necessary to the station in the air. The preceding considerations had only the one aim to look for the mode of translation that it will have, for the "How it will behave in the air." According to the attentive observation of the different forms of flyers that I could see, it follows that it will move like the being which it most resembles ~~as~~ a whole — it is without argument the dragonfly! It will therefore have the qualities and the faults of this neuropterous insect, which means as quality of great swiftness, but as a fault a forced rectilinearity of the course, just as the very elongated boat comports itself which has great swiftness but turns with great difficulty.

There remains a great number of details of construction; small difficulties which are destined to be overcome one after the other by an ingenious engineer.

Mouillard

Cairo
March 28, 1895

Mr. O. Chanute

My Dear Sir,

I have the pleasure to announce to you that I received the visit of Mr. C. Sooy Smith who gave me your kind letter. Unfortunately due to indisposition of your compatriot and to his early departure the visit was single and brief. I couldn't enjoy his company. We limited ourselves to talking about you; concerning this he told me so much good about you that I find the time long before I can see you. We had time only to find out that I have so many kites (small birds) in sight that the study of aviation is an easy thing for me.

He was in such a hurry that I couldn't show him my machine whose parts were scattered at the constructor's shop. He had arrived at Cairo some days ago and had to stay in bed until his departure. He asked at the last moment if they knew me; by chance he just asked a porter at his hotel who had been my clerk and who had him shown directly to me; it is due to this chance that I met him.

The easiest way to get into contact, if the occasion presents itself that you again send me somebody, is that as soon as they arrive to inform me by mail; the mailman comes twice a day and I am posted at once.

On the other hand I have to tell you that I have given up the aluminum. To give up this metal on which I had founded so many hopes is a serious thing. Here is what happened when I had it in large quantity in hand: After feeling and testing it I saw that I had been mistaken, that it was brittle, folded with difficulty, weighed 2.75. It is needless to tell you how hard it was for me to give up this beautiful dream. There happened what always happens to me, although I am a dreamer, when I get a blow, I turned around with good sense. I thought again of the wood that I had despised so much and that has its good points, I remarked what I had put out of my mind, that a strong bamboo of 4 m carries me perfectly and weighs 5 kg while an aluminum beam weighs 9 or 10 and is entirely unknown to me as to its strength; finally that I was to produce a monstrous wolf of 200 kg weight, while with the wood and the bamboo I gain 29 kg, a difference of 75 kg. So I turned around at once, had a carpenter's workbench put up in my room and this morning the body (the frame) waits for the iron fixings which are late. My helper, my smith who hadn't seen me for several days, came to see me. He found himself faced with this nailed frame, glued, in place and waiting for him to have finished. But, my dear Sir, my hands are in a strange state. Useless to say that I am not good in carpentering, still it came off. In fact I laugh about these abrasions of the skin, one has to go on and quickly. I wish very much to surpass this theoretical aviation,

for I found a use for this airplane that is entirely up to my aspirations. Only in wood this machine doesn't stand the water and I should be in the sea. In fact if I finish this airship incomplete for the demonstration, we may hope that we will later get to construct one that will float.

Affectionately

Mouillard

.....

When Mr. Charles Sooy Smith returned to the United States he wrote Octave Chanute a long letter. The part of the letter that pertains to Mouillard is quoted below:

Green's Farms, Conn.
April 29, 1895

My Dear Mr. Chanute:

You will, I think, be interested to hear of my visit to your Cairo friend, who, while I saw him but once, seemed to me quite unique in his way. I had expected to look him up soon after reaching Cairo but I was temporarily laid up as a result of too much pyramids, etc. and did not see him until just before I left. The porter of my hotel knew him and so I went direct to his house. He lives at the top of the highest house in Cairo with the birds flying about his windows. We started off at once talking about his interest in aerial flight. You have doubtless heard that he has given up the thought of aluminum and turned to bamboo as the best suited material for his purposes. He spoke with much regret at not being able to use the plates you sent. The machine he had had come to grief so I saw nothing. He told me how he had come to take up the study and from his window showed me by far the best opportunity I ever saw of studying the flight of birds. The slow steady motion of those vultures (if such they be) coming so close to his window above, below, and opposite gave an ideal view at close range. He said they all knew him and one or two he seemed to single out as special friends.

He inquired very particularly about you and your family and I was surprised and interested when he told me that he had never met you and sketched the origin and growth of your friendship. Your photograph stood on his bureau. Coming pretty fresh from our practical American world, the man and his enthusiasms with strange surroundings made an impression not to be forgotten. It is pleasant to realize, as one can occasionally, that there are still many lofty minds working in the pure fields of science not yet too much hampered by immediate utilitarian ends.....

Sincerely yours,

Charles Sooy Smith

Cairo
April 14, 1895

Mr. O. Chanute

My Dear Sir,

I returned from a short excursion and I found your sad letter. Is not life cruel, my dear Sir. To raise a child, make a man out of him, to see him prosper and finally to lose him, see him disappear when everyone depends on him. Why? It is so to persuade us that everything goes haphazardly down here.

I understand Diogenes and the stoics and even the Nihilists. Nihil. There is nothing. The globe down here goes around, but certainly God doesn't lead it, or else the order of things would be less incoherent than it is and one wouldn't see the young head of a family disappear when his children need him. Forgive these reflections, but it is revolting to see a world so stupidly led.

If I dared I would ask you, although I don't know them, to give to all your afflicted ones my condolences very absolutely sincere, of this misfortune that crushes them and to you, my dear Sir. In fact, what can one tell a father who loses his son. There is only to submit and to say: Fate wanted it so, whom should I blame?

I share the desolation in which you must find yourself, and yours, and advise you to work hard. That is a powerful antidote for sorrow and gives one a few moments without suffering; in a word, it is a help.

My airplane satisfies me except the slowness with which the construction proceeds. It is very difficult to go quickly in this country where there is nothing.

Adieu, dear Sir, I don't know how to express the part I take in your sorrow.

I am more and more devotedly yours

Mouillard

April 18, 1895

Mr. L. P. Mouillard

Dear Sir,

I have just received your kind letter of February 28.

I hear with pleasure that you have decided to use wood and bamboo for your machine, for not only is wood lighter for equal strength, but I think that you will have to reconstruct several times before achieving a satisfying success. As always I wish you good luck.

I suppose that you can sell your aluminum without loss. The government must need some.

I am very intrigued by the use that you will make of your machine to earn money. In your letter of February 25 you tell me that you have solved this question to your great satisfaction and in that of March 28 you say that you have to be on the sea to use it. I try to guess and I only find piracy.

I had earnestly recommended to Mr. Sooy Smith to send you a word by mail as soon as he arrived. It seems that the climate of Cairo makes one forgetful, for he has done like Mr. Scott last year to whom I had recommended the same thing. The latter just died suddenly in New York from a stroke and I send you a newspaper clipping.

The second model of my demonstration machine is nearly finished, and we will make experiments to determine the position of the center of pressure at the different angles of incidence. If they succeed, I count on going on to the construction of the machine in large size.

You were supposed to send me the description of your own machine. Receiving nothing I thought that perhaps you changed your plans in the course of construction, but if you are satisfied now and don't see any inconvenience, I should be glad to know with what you are going to throw yourself in the air.

Sincerely

O. Chanute

P.S. Give me also the solution that "Babs" found of the situation described on p. 106 of "L'Empire de l'Air."

May 3, 1895

Mr. L. P. Mouillard

My Dear Sir,

Of all the letters of these months which have expressed their sympathy on behalf of the premature death of my son, no one has been as heartfelt as yours. I feel that I have gained your esteem and your friendship, and I thank you for your kind words.

As you advised me, I buried myself in work, and I begin to forget the blow that struck me although there remains a great pain. I submit and I work, for the world is governed by general rules which don't take into account the good or the bad; it is still possible for the individual to do something good for others by making use of one's capacities.

Very sincerely,

O. Chanute

Let me know when you hope to begin your experiments. You know that I still keep another sum of 2500 fr. at your disposition in case of need.

Cairo
May 10, 1895

Mr. O. Chanute

My Dear Sir,

I mail today a roll of business papers to your address containing: seven pages of an article in which there is explained the worthy deed of my dog, and three note books where I have written my thoughts on the use that I could make of the airplane. Please excuse me for sending you notes written in pencil. I wrote them for myself only, but it is so long and so tiresome to copy oneself that I take the liberty of sending you my notes the way they come out of my pen or rather my pencil. I beg you to return them when you will have read them.

I cannot at the moment have a photo made of my airplane because it is strewn over different places. As soon as I'll have it completely or at least completely enough to be comprehensible, I'll have the photo taken and I'll send it to you. That will be soon. Regarding the inconveniences that I may have to divulge what is for me your possession, I don't see any as I know exactly that I don't have to be afraid of an indiscretion.

I see that I am forced to wait for the winter to make my flying experiments. I shall not be finished for three months, and that will be just when the cooler weather sets in. I am going to be the judge of my own courage and it is discouraging to see how little there is of it. I shall proceed progressively and shall try to avoid as much as possible the disagreeable surprises occasioned by too strong a wind; but, in the end, one has to submit one's self if one wants to fly. There is certainly a frightening effort of will power to be put forth, but there is no other way; to vanquish the horror of empty space is absolutely necessary. I'll submit to it with all possible skill, but anyhow I will submit. I was delayed so long in life that I am forced to take a terrible leap to join the rank to which I think I am entitled.

I beg you again, dear sir, to excuse my pencil. I decided to send it to you because I remembered the proverb: Time is Money.

Affectionately and devotedly

Mouillard

May 30, 1895

Mr. L. P. Mouillard

My Dear Sir,

I received from Mr. Karl Wills, aviator from Vienna, a booklet in which he proposes the same method as you to change the position of the center of pressure, by advancing and retracting the end of the wings. It is indeed the method recommended by D'Esterno but the Germans will study it more seriously.

My own experiments to realize automatic equilibrium have not at all succeeded. Mr. Herring made me two models, one with 16 wings, and a second ($1/3$ of natural size) of 12 wings. These wings do harm to each other, because of the wake which makes the first pair of wings support much more than the following wings, and that the center of pressure varies nearly as much as if the surface were not interrupted by the space between the wings. I would have tried other combinations of multiple wings, but Mr. Langley has just now taken Mr. Herring away from me by paying him twice as much as he was getting from me for his own experiments. I offered to Mr. Langley to tell him about my studies if he would do the same exchange later but he has refused, saying that he could not give the impression that he owes another some ideas that he himself has conceived.

He has succeeded in producing several trips of his steam engine, propelling by a propeller an airplane of Pineau type. The one of 60 meters, the other, they say of 300 meters, but equilibrium is missing in the wind and he is going to reconstruct his machine completely. Mr. Herring has been engaged for that.

The circumstances may warrant that we withdraw the American patent from the state of delay that you know, in order to take patents in Europe. I send you a power of attorney that will enable me to do it. Please be kind enough to sign it in the presence of the United States Consul before two witnesses, and send it back to me. I'll then take the patent in our two names each one owning half of it.

You will remember that the former convention is in general terms which doesn't authorize me to put my name in the American patent.

I wait with impatience for the description of your first trials. I have received nothing from you since April 14.

Yours with a handshake

O. Chanute

June 8, 1895

Mr. L. P. Mouillard

Dear Sir,

I received a few days ago your kind letter of May 10 and your business papers and I return these in a roll, registered.

I congratulate you on having found so many applications for your airplane. If it succeeds it will be necessary to make a list of these uses to be published in the catalog and follow the industrial method which consists of leasing out with a royalty instead of selling a machine that promises great gains. That is frequently done in the U. S.

Naturally if you succeed you cannot exploit all these projects yourself. I even believe that all your time will be taken up in perfecting the machine, in fighting the imitations, and in keeping track of the fundamental, the useful, and the incidental results.

All these, for the present, are midsummer dreams. The essential thing is to succeed, afterward we'll put the dreams in action, really and truly industrialized, by organizing companies that will give out shares. I believe that they would sell well, with the help of imagination.

I was altogether charmed by your seven leaflets of articles. You are unexcelled when you tell anecdotes about animals. All these should be incorporated into your book, at the places that need to be enlivened.

I acknowledge that your dog Bobo was more intelligent than I am. I had found out that he had jumped on the back of the calf, but I asked myself how he could avoid flattening it. Only the thing is a delicate matter to explain, and it seems to me that I'd simply say that the dog took hold of the calf with his fore-legs. You know that we are very prudish in America.

As I told you before, a photo can only give me a very imperfect idea of your machine, but as I have already made the experiments that I explained to you and as I can make others later on, I prefer now not to know the details of your machine before the success. I hope that this will be soon, but I imagine that you make changes according to the time that it takes.

You will certainly hear with pleasure that recently I have been elected an honorary member of the Society of Civil Engineers of Great Britain, a very important Society. The French and German Societies had already sent me tokens of their gratefulness for my services to the engineers during the Chicago exhibition.

Sincerely

O. Chanute

Cairo
June 15, 1895

Mr. O. Chanute

My Dear Sir,

By keeping on our march we finally see the end of the road. I begin to perceive the end of this interminable airplane. I would never have figured that this would take so long to construct, still one would copy it in a week, but between copying and creating there is a far cry.

The body is scaffolded; it rests on two wheels. Too heavy these wheels! But I don't dare to make them lighter for the try-outs; one is so clumsy in making the first steps that I prefer an exaggeration of strength to too much lightness which would engender weakness.

What a collection of corrections I had and will still have to make, so I decided to keep on reenforcing, that means do all over again and in another system, the soul of the machine, the tube which carries the whole, the point where the wings are attached. It is the fourth change, and I think it is compulsory because it is decidedly too feeble. This done, there will be nothing left for me to do but to attach the carrying surfaces. That goes quickly.

In order to make the wings, I have two lovely bamboo of 4.17 m length and of 0.275 of radius at the thick end, 0.19 at the fine end and nearly exactly alike for curvature and weights. I put the two ends of one of these bamboos upon two chairs and I let myself be carried in the middle without the bend produced being disquieting. Never could the aluminum nor the steel pretend to produce such a feat of strength in resistance. I succeeded in obtaining as rudder tail feathers two bamboos that are absolutely similar as to strength and shape, one of 3.97 m length and 630 gm of weight and the other cut the same length and of 670 gm. When you have them in your hand their weight seems unbelievable; one can hold them with outstretched arms with an effort of 5 kg, in the other positions one can handle them easily with 2 fingers. For testing I put one on the shoulder, the fine end carried on the ground. I tried by an effort of the arms to break them. I only succeeded in curving them at a deviation of 0.50 m, but one must say that in spite of their minimum weight they have 0.10 m of perimeter at the base and are as thick as the thumb at the pointed end. They are it is true perfectly dry but I am sure ---

(I have just received your kind letter of May 30, 1895 and the power of attorney that I will have legalized tonight and return to you probably today. I don't know if you have observed that I don't tell anything to anybody neither by talking nor by writing; it seems as if I don't know how to write anymore. Your letter

seems to indicate that you are in the same disposition. I believe that the time of conjecture is over and that production is starting, but to be fruitful one must not give to others the means that one uses.) So I go on with my letter -- that they have not 0.005 of thickness. The two big ones of which I have been talking to you are not yet dry, but I can tell you that exactly green they weighed together April 25, 12 x 626 gram. Weighed again the 25th of May their weight was only 7 x 284 gm; lastly weighed again June 4 their weight had come down to 5989 gm, always weighed together. They will not be in a state of complete dessication before two months. I hope that then they will not weigh more than 5 kg. These choice materials will make the construction of the carrying planes much easier which is certainly not yet an easy thing to produce. In a month I'll speak to you about the difficulties that I will have met.

In order to make them I have to find a place other than the one that I now occupy, that means a room of at least 12 m length instead of my bedroom that has only 3. I hope to have found it. As soon as it is mounted I'll have it photographed under different angles and I'll address it to you with the necessary explanations. Is it very prudent? A photo is so easily stolen. Please answer.

In your letter before last you had the kindness to tell me of a sum that you still hold at my disposition. Please allow me, dear Sir, to thank you again. I hoped that I wouldn't need it and would get along with the first 2300 fr that you had the kindness to send to me, but I didn't take into account a misfortune that befell me. I have been dismissed these days by the Administration of Public Works for interruption of work, a momentary interruption but I don't see the end of it coming before the return of the chiefs at the end of September. So I am forced to live now on the returns of the little herb shop and my meager savings as a clerk with 300 fr monthly, which means that I am afraid to be short for the finale. How shameful it is to be poor! It is absolutely a crime. But unfortunately it is like that. I must not hide it any longer if I don't want the airplane to suffer from it; for this machine will put in my hands and for the first time the serious means to direct my destiny, something that I never had before and which the other aviators haven't had any more than I. Lilienthal has reproduced my airplane No. 3 and has stopped his experiments for the same reasons as I, when he was persuaded that the control devices were insufficient and that he was heading inevitably for an accident. The present machine is certainly of those I have made the least bad as an airplane, although it is horrible and ought to be done all over again; it could be made over so quickly and infinitely better that often the temptation to do so comes over me and only the expense stops me.

This machine in spite of its imperfections will certainly produce at least the demonstration of two directions, vertical and horizontal. The demonstration of the strength of the support of the air has been done a long time ago. Now, it is to be hoped that

while I am at it, I will dare to go further. I will be absolutely forced to produce "penetration" because the tryouts will necessarily be made by frontal wind and it is only later that I will dare to fly with a rear wind. As for ascension, it is not I who will attempt the first acts. It is the gust of wind that will force me in spite of myself to ascend. In order to escape this terrible gust of wind, I will be obliged to fight against it by pointing the tips rearward by means of the screw; by this action I will reach the point of equilibrium and will keep myself there. By this maneuver I will have avoided overturning and will have produced "aspiration", not as I produced it in Algeria, which furnished 42 meters by the goodwill of the wind (which matched my speed), the carrying plane, and coincidence with the center of pressure. This time I shall produce aspiration with full consciousness; the research of this point I shall obtain by means of the screws and also by an act of will; in short, just as the bird does. This result will not be accomplished easily nor at the first attempt; we may face ludicrous or tragic moments. I shall certainly not invite anybody to witness my first flights; I shall act progressively and carefully, being very certain that no accident will prevent further trials.

I count on finishing during the month of September. At that time the desert is livable; one can stay there nearly the entire day without fear of sunstroke. I have prepared a shelter for myself near Cairo, half an hour's drive in a carriage from the center of the city and in these good conditions there certainly lies helpful elements of success. I want to do everything that is possible. Only I tell you in advance that at the first serious flight I will wire you and I beg you to come.

I am grieved that I could not finish my task with the sum of money that you were kind enough to send me. I came as near to the goal as possible, but where I was mistaken - or rather what I did not take into account - was the expense needed to make the tests.

I beg you to excuse me, dear Sir, I am so worried to have to write you this letter; it is lucky for me that I am not right now on the testing field, for I should be strongly induced to commit a great imprudence.

A devoted handshake

Mouillard

The Consulate is closed in the evening; tomorrow is Sunday so I cannot have the paper legalized until Monday.

Cairo
June 17, 1895

Mr. O. Chanute

My Dear Sir,

You will find in this letter the deed that you sent me, legalized by the Consulate of the United States according to the rules that you indicated to me.

I confirm to you my letter of June 15 which will perhaps arrive together with this one.

Sincere handshake

Mouillard

July 7, 1895

Mr. L. P. Mouillard

My Dear Sir,

I received your letters of June 15 and 17, nearly at the same time, and I send you a draft No. 3358 on the Credit Lyonnais in Paris for 2500 frs. I hope that it will be enough to lead you to success, but let not the money question induce you to do something reckless.

I read with great interest the details you give me on the material that you use. I advise you to get hold of seasoned bamboo - to have it dried.

If you think it unwise to send me the photographs of your machine, put them in trust with a friend, as a further proof of what you have done. Still, it's hardly to be feared that an indiscretion will happen except in Cairo, for once they are in the Post Office, your letters will not be opened again. But if you send me these pictures, mail the explanations in a later letter. Being of ordinary size, that letter wouldn't be stolen like one containing the proofs. The pictures need not be mounted; I'll do that myself here.

I wrote to Mr. Karl Mills to know more exactly his idea. This leaflet shows a machine whose wings can be advanced and retracted on a pivot but he doesn't say if it is to do gliding or whether he means to add a motor. I asked him this question June 10 but haven't received an answer yet.

Certainly if you succeed in the first tryouts, I'd be strongly tempted to go to Egypt, but I am not sure I will be able to do it at a fixed date. You would do well to tell me by mail what are the steps to be taken according to your judgment in order to take care of your rights. To me it seems that

patents have to be taken in France, England, Belgium, Germany, and Austria and perhaps in Russia; those are the countries where the machines can be fabricated. If they are fabricated in other countries we can forbid the sale in the countries where we have the patent.

There is another solution; it is to keep the secret of the machines and to sell this secret to the governments for war machines. Can one keep the secret? Can one use this machine for war?

I wish you good luck and shake hands.

Cordially

O. Chanute

July 21, 1895

Mr. L. P. Mouillard

Dear Sir,

Mills

I received a letter from Mr. Karl Mills of Vienna in which he tells me I can tell you that I have nearly completely finished a machine of my invention, at which I worked for years, which will be completely dirigible. I hope and trust that these provisions will be realized and I will let you know the results as soon as possible.

You are mistaken if you believe that I use a propulsive apparatus. I believe that human strength is amply sufficient to produce the necessary energy for flying, without the help of an outside energy - motor or wind. I believe that gliding flight is accessible to man, but I also believe that it needs an extraordinary skill, and that this manner of flying will not be achieved for a long time. Human energy is sufficient for flying, that means to get going, to keep the speed, and to rise obliquely. The only impossible thing is to rise vertically.

As you see, that isn't very clear.

Sincerely

O. Chanute

Cairo
July 24, 1895

Mr. O. Chanute

My Dear Sir,

I received yesterday your kind letter of July 7 and the draft No. 5358 of 2500 francs that was in it, for which I thank you with all my heart. With this sum I can determine at my leisure what this machine can do when directed by your servant.

What is new since my last letter is that I have located a perfect spot for what I have to do. For 25.25 francs per month I rented an old nunnery. I do not remember to which order it belonged but those nuns have great faith in me and I stay right in the midst of them. The place is huge; there are 20 rooms, all in ruins it is true, still there is space. I occupy only one room that is 6 meters wide and 15 meters long, and a large courtyard of 20 x 15 meters. So I can develop my wing-spread, which is about 13 meters. The part of the convent that I occupy is haunted by ghosts. I am not much of a spiritualist, as you can find out by my writings; still, I confess to you that I have been greatly intrigued more than once.

It is an ancient Turkish palace, 250 years old; there are splendid ceilings in woodwork that are masterpieces of Arabian art; all this woodwork is cracking and crackling, reverberating sounds produced very far from there, mystifying the most skeptical man. I caught myself climbing 10 times to the upper floor which is uninhabited to see who was there and there was nobody. At last I found out why these quarters are unoccupied. It is an acoustic effect that mystified many people and especially the nuns who are very happy that I found a rational explanation of the noises that were so disquieting to them.

How difficult it is to make a flying machine. For every device one is up against a new problem. One thinks he knows this device very well, then if one goes on to the construction, one begins to be puzzled; what one is building doesn't stand up, is monstrous, too heavy or too weak and altogether doesn't work. One has to do it over again quickly and it is very seldom that by the second time one succeeds in doing something satisfactory. I may say that I have constructed more than three machines. Today or tomorrow two large hinges in sheet steel will be completed. I had them done over again for the fourth time. The two large bamboos that I liked so well which I told you about have been abandoned on account of weakness. I was obliged to replace them by two other bamboos very much stronger. They are real girders, 4.30 m long and 0.15 in diameter, weight about 10 kg for the two. It is always the gigantic bamboo that is inimitable in firmness; the metallic tubes do not by far approach this resistance and this lightness.

I count on having finished and being able to proceed to the tryouts at the beginning of the cool season, that is the end of September. There are certainly some precautions to be taken against stealing. I am afraid of the practitioner, my clerk, who has to construct all the iron devices. He is an Italian. The smiths and mechanics here are all Italians; they speak an idiom among themselves and are laborers. I believe that before the experimentation we should make a deposit at the French Consulate and perhaps the American of the description and the drawings of the machine. In the experimentation, which will take time, I will try seriously when I am alone with Arabs who are of no importance; so if I have to try I'll take advantage of that moment and I am not going to do anything as long as there are intelligent witnesses around. The secret of the machine cannot be kept; there is this Italian aide who knows it as well as I do; but there is one thing that baffles him. He is conscious that I know flying by heart and that he doesn't understand it at all. There, I believe, is my real protection. As I do not instruct him on the theory of flight, he searches I see, but he does not understand anything about the equilibrium of the machine and about its control. My idea of disappearing as soon as the first take-off is made and to make studies at the Red Sea where there is nobody is based on this necessity of isolation. There I will need you absolutely for this war question; (read again carefully the last chapter of the "Empire de l'Air" - that will persuade you that I considered those questions); this isolation will be my strength and my protection; for without having acted, without having done any wrong, I have to be afraid of the Governments. Bad advice is inspired by fear. I must not be in their hands. I do not know how this question will be solved, or better how you will solve it, for once I have left I will try to be visible only for you and two other persons; and all that without having done anything reprehensible except killing some peepers (Puffins?) to get hold of money. It is a delicate point that requires long conversations and hard thinking. It is for this reason that at the first shadow of success we should meet. If you cannot go to Cairo, I can now travel and come to the United States.

This is becoming serious and will be more so right after the first kilometer covered. Now there cannot be any question of retreating.

I thank you with all my heart, my dear Sir, and am always

Devotedly yours

Mouillard

Chicago, Ill.
August 17, 1895

Mr. L. P. Mouillard

Dear Sir,

I have your kind letter of June 24, and I have read with great interest the details you gave about your Turkish palace and of the tribulations of the construction of your machine. One does eventually get finished, if he just keeps on.

I believe that you worry too much about the intervention of any one government. Certainly the English will leave you in peace. The French will say that a machine that does not go when there is no wind, is not a war machine. As for the Egyptians, you know them. It is certainly difficult to project one's self by imagination into the unknown, but the evolution of gliding flight seems to resemble (on a large scale) the evolution of the bicycle, which took more than 30 years to become practical.

You will have some breakage in your first tryouts. You will have doubtful successes; some small ascensions with retardations; maybe even some semblances of aspiration; then a gust of wind on one side will make you descend in a hurry. You will break a wing. You must repair the machine. Then I hope that you will have a real success, and therefore it will be dangerous. Your machine is built in such a way that it will reach the ground before your body does. Lilienthal says that with a little skill one succeeds always in breaking the machine rather than one's own bones. You will perhaps do like he did: produce a certain sensation at the first serious success; then suffer a failure that will make you cry, "This business is a flop."

So I think that you should be entirely wrong if you were to disappear in the desert, where you would have neither the chances to repair your machine, nor the necessary care in case of sickness or accident. I believe the latter case is not very probable, because to me you appear to be very cautious and to have full knowledge of the experiment, but you have to think of every contingency.

If it were not for my wife, I would decide right now to come and see you this winter. But she is afraid of the ocean crossing for herself and, since my older son's death, I hesitate to leave her.

Well, we will see. Keep me informed of your progress and believe me to be

Yours devotedly,

O. Chanute

August 22, 1895

Mr. L. P. Mouillard

Dear Sir,

Having read in a German advertisement that Lilienthal offered to sell duplicates of his machine for aviation, I wrote him in the name of an exhibition that will take place in Denver next year, to know his terms.

He answers me (August 6) that he wants to sell at the same time his American patents, including one that he is going to ask for. That he has recently added a combination to his machine that adds so much to the equilibrium that anybody can easily learn to use it, so that gliding will become a sport and that the machines will make commercial profit. I have asked for his price.

A certain number of Lilienthal machines have been sold in Austria, in France, and in England. The sport enthusiasts often fell on their noses, and the vogue was passing when Lilienthal added his combination. I have no idea what it can be, but I hope that yours is better. The city of Denver is at the foot of the Rocky Mountains, 400 miles from here. It is going to have an exhibition of its minerals and its industries that will open July 7, 1896. In order to attract the crowds, the Administration considers offering prizes for the best machines of aerial navigation. They have consulted me and I wrote to several people. If your machine succeeds, it would perhaps be useful to exhibit it in full action at this exhibition. The only objection is that the city is at an altitude of 1700 meters and the air is very light. Would you like to try it? Here is an occasion to avoid the governments that would want to put their hands on your war machine. From here you would be able to hold them at a distance.

Very sincerely,

O. Chanute

Cairo
August 30, 1895

Mr. O. Chanute

My Dear Sir,

I have just spent a month working very hard. What a lot of work there is to bring to a good finish this big machine! My health is good, I fight against the heat and am able to do good work. By the end of September it will be as I told you well advanced, but how big it is and how heavy ! I am speechless. I confess that it is the first time that I have seen such a big machine as this. I am faced every moment with the terrifying problem of the strength of the matter compared to its weight. I ask myself every moment: Will this carry me or will it not? If stronger it has to be heavier, and if it were weaker it would break.

I convince myself more and more that what I am producing cannot be anything else but a demonstration airplane; it is not perfect enough to consider getting much use out of it. But if, in fact, it will demonstrate only the gliding motion of a sailing plane and its main evolutions, I'll be satisfied and a more perfected machine will soon be produced.

I made it large to be able to go as slowly as possible and by the feeblest wind, knowing by experience how afraid one is and how much one must beware of the irreducible fear of the instinct of self-preservation.

As you see, I do all I can in order to succeed. I take care to put as many trumps in my hand as I possibly can, but I acknowledge that I have harnessed myself to a redoubtable problem, especially this time when I do not preach in a platonic way for the others; but I am constructing for myself, I myself will be the operator, and that consequently I have to do the necessary things in order to succeed without breaking my neck. In short I have never had so many worries and work as I had during the past month.

At the end of September I'll have one or several photographs made of the machine and I will send them to you by insured mail. I am not much afraid of having it stolen for I am convinced that not only do you have to have a machine to produce flight, but also and even more so, possess the knowledge of flying, which is not learned in a hurry. Well, dear Sir, there is where I am standing now. I hope that I will not have any big miscalculations, because I believe that I weighed everything carefully. But there is a large part of the unknown that should not be stressed anymore than necessary; so I had a surprise that I did not expect, it is to see the framework of the wings in position, it means fixed to their chariot; it has a very curious effect. Certainly it is the

greatest pair of articulated wings that has ever existed on the globe. It has more than 13 m of span and 30 square meters surface. And it holds together! And I strongly believe that it will carry the aforesaid 130 kg which I believe will reach well nigh 150 kg. The rest is action. We shall see that in a month.

Very proud and very happy to be satisfied with his work.

I wish, dear Sir, all that you wish for yourself.

Devotedly

Mouillard

September 16, 1895

Mr. L. P. Mouillard

My Dear Sir,

I have just received your kind letter of August 30. I deduced from it that you are satisfied with your work, but that you are speechless on account of its size and its weight, which will climb up to 70 or 90 kg.

Don't get discouraged, and if there are signs of weakness, trim bravely the spread of the wings. I am sending you the "American Engineer" of September in which you will find (p. 434) the drawings of Lilienthal's machine. The dimensions are in English feet and inches. The span is of 7 m, the carrying surface of 23.5 square meters without counting the two rudders, and the weight is 34.55 kg. This machine demonstrates only gliding. I hope that yours will make us perceive ascension, and perhaps aspiration.

You will receive these lines when you are about to start the experiments. I wish you good luck and much courage, and shake hands.

Very devotedly

O. Chanute

Cairo
October 7, 1895

Mr. O. Chanute

My Dear Sir,

I believe it will take another fortnight to finish this endless cover. How many thousands of stitches and strings one has to make! I had tried to obtain the help of seamstresses but I had to give it up because the women sew so badly and especially with so little solidity that I got upset more and more. Still I will be forced to get some help for I see that alone it goes too slowly.

I received your kind letter of September 16 and the American Engineer. It is just as I had supposed, nearly complete absence of the two directions, and it is this absence of directing facility that immobilizes him. Certainly it is not with this system that one can produce flight; the same thing that happened to me during my 42 m run must have happened to him. That means the ascertaining that one is getting lost, for one perceives clearly that one is not master of one's direction, that one is very nearly going by sheer luck, that as soon as the wind changes from its regularity one is in danger of being thrown over or knocked over, and, in short, it is a machine that has to be made over again, better pondered upon and better understood. He still has much to learn.

In mine, now that I see it well, I think that even being so imperfect and so crude it must be able to glide on the calm air as soon as it will have a speed of 7.50 m and maybe even less, meaning 5 meters; then, that it will be able by means of the displacing allowed by its construction (the angle permitted by the screw) to penetrate a current of 10 m, perhaps 12 m or 50. Certainly it is not sufficient as a general rule, but as I have already told you I couldn't from the first arrive at perfection. Still, as it is now, I hope to be able to produce interesting experiments. And this in spite of the fact that as soon as the weather will get too cool I must come down, in spite of the fact that I cannot venture to land on the water for fear of the calm that would make me fall into the sea and get drowned, for I don't float. There should be another system that is well established in my head, but I didn't believe and didn't dare that I should begin with that one. I believe that a few kilometers of distance covered during the try-outs would permit to think about the creation of a society endowed with a capital that would permit me to construct at ease and to be able to begin again without hesitation. This will tell you that if I dared I would begin all over again in order to do better. In fact, creating something perfect at the first trial seems to me pure luck. Still, as it stands now, this airplane produces a strange effect on the persons who have seen it. It made them understand how it is

capable of carrying a man. As to the questions of control, they have fortunately seen absolutely nothing; but for me, who judges calmly, it is close enough to what it should be to do well. Still one must not be too affirmative, one has to see how it will behave when it has to carry itself and to carry me. I am apprehensive about this first experience. Well, at the end of the month we will come to this practice that has so many surprises in store.

I shake hands very affectionately and am

Devotedly yours,

Mouillard

October 31, 1895

Mr. L. P. Mouillard

Dear Sir,

I received your kind letter of the 7th and for the past few days I ask myself every morning if you are up in the air, ever so little. I believe that although your machine is imperfect you will make interesting demonstrations. I am holding up an article that I have to write for a Review with the hope that I can speak in it about your experiments.

I believe that you are a little bit mistaken about the Lilienthal machine. He says (see the Aeronaute of January 1894, and my supplementary annotations) that nothing is easier than to control this machine. One has only to bend oneself to the right or to the left, in front or in back, and gravitations produce the necessary change. Still I see very well that a regular light wind is necessary in order to succeed very exactly; but if he would consider putting a hinge at the intersection of the circle and the assembling piece of the ribs, and adding a rubber string between the first rib and the circle, he would have a great improvement.

In fact, Lilienthal wrote me the 5th of August that he has lately added a few improvements to his machine that would make the use of it easy to anybody. He doesn't explain himself more fully. As he indicated at the same time that he wanted to sell his American patent, I asked him how much. He answered that he would accept 25,000 frs and that he would agree to tell all the improvements that he would make in the future. I tried to find a buyer among the bicycle manufacturers, but I have not yet succeeded.

You see that his pretensions are very moderate. He writes me too that his machine will cost, if made commercially, 125 frs and that it is sold for 625 frs.

I am still wishing you good luck and shake hands.

O. Chanute

Cairo
November 7, 1895

Mr. O. Chanute

My Dear Sir,

My airplane takes so much hold of me that I leave my correspondence in a sad state, and that in order to get it all answered I have to give a whole day to it. My machine is nearing completion. How horrible it is! Now that I see it calmly, I'm not proud of it. It is exactly a collection of bits. It is frightfully heavy, exactly 152 kg (myself included) meaning 5007 gm of load per square meter. I am not much mistaken, but after thinking it over, how much better I could have done! In fact, to produce perfection right at the first is not possible in this world I believe.

When I compare it to the bicycle, I am ashamed. Still I must state that the bicycle, as it is now, is the product of succeeding improvements of at least 1000 individuals, all of them specialized constructors, well provided with tools, perfectly organized and learning all on each other, resting on known facts, in fact, perfecting only an already perfect piece, while I have to create the piece, to create it, to find out, in short that this device is necessary, that it has to be brought out in this world, so it is of a clumsiness that makes me laugh. I have already a pretty collection of abandoned things, stillborn, that I couldn't think of putting in place and some which to my sorrow must be discarded as thrash.

I must say that the principle hasn't ever suffered the least change with me; it has stayed immutable, but those details! What an upheaval one would have to do in order to satisfy me. Well, you will judge by yourself, in my next letter that will have the photos that I am going to have made.

I believe that I must tell you something about the Cholera that is here in Egypt, as the newspapers announce. What there is I believe is an attenuated cholera, on the borders of lake Bengala, 50 miles to the north of Cairo, probably brought here from Syria and which is kept nourished by these numerous centers of infection that the fisheries of the lake are creating on the lake where they prepare the "fissich" preparation without a name, unknown in other parts, delight for the lower-class Egyptians, which is a slightly salted fish, put to ferment in heaps of about twenty cubic meters. The intestines are rotting around the huts of the fishermen and give forth an odor that is evident miles away.

It is in this frightening milieu that the sickness has spread, in in spite of these special conditions it does not increase, has frankly the tendency to diminish and as it is does not scare anyone in Egypt. In Cairo, Alexandria, and the rest of the country there is not one single case. Moreover the travellers are reassured and return in quantities. Yesterday I saw 45 carriages following each other and going to the Pyramids.

Soon now, dear Sir, the letter with my masterpiece.
Affectionate handshake.

Devotedly

Mouillard

November 28, 1895

Mr. L. P. Mouillard

My Dear Sir,

I have just received your kind letter of the 7th. I am happy to know that your machine is finished at last, and the load of 5 kg per square meter doesn't seem excessive to me. Only I believe that there is much to pare off the weight of the machine and of the carrying surface. A machine like Lilienthal's with the modifications that I indicated to you in my letter of October 31 would weigh about 24 kg. I have asked an American patent for this modification, and if I get it, I'll assign half of it to you.

In the beginning of this month I had a chance to go to Europe, but I didn't take advantage of it. My brother-in-law who has been sick for a year has been ordered to spend the winter in Nice. He wanted very much that I should take the trip with him and his wife. I offered to my family to take them along, all of them, naturally, with a thought of Egypt. After many discussions, my wife couldn't make up her mind to cross the ocean. My brother-in-law left directly on the 8th for Genoa.

My wife's health is delicate. I will take her to the South after January 17 and although I wish very much to come to see you, I cannot promise it for certain. That will depend first on my wife's health, then on the nature of the success that you will have. As I have always told you, I think there will be some breakage, and I hope that you have some replacement parts. It may happen easily that one or two months will pass in making the first try-outs, and that you will need me only in the Spring.

I tried to find a buyer for Lilienthal's patent for 25,000 frs. They answer me that the machine is not perfected enough to make a commercial success out of it. After one or two years of good will, the public falls back into indifference and doubt about the success of the flying machines. So it is up to you to solve the problem. I wish that for you with all my heart.

Cordially

O. Chanute

Cairo
December 7, 1895

Mr. O. Chanute

My Dear Sir,

Enclosed are three photos of my airplane. The place is not large enough to permit the obtaining of a photograph of the whole and I had to have portions taken at a time.

No. 1. Left wing and undercarriage. The tail is not in position.

No. 2. Airplane seen at three-quarter view. Your servant is in the carriage. (It does not look like me at all; it seems that I moved.)

No. 3. View of the airplane taken from behind in order to show the screw and the mechanism. The tail is in position. The photo of my aide is very good.

The wing spread is just 12.25 meters. The weight with myself included is 152 kg and the surface with all wings spread out is a little more than 30 square meters. There is to this airplane an enormity that is not evident in the photographs. I do not know why this is so; very probably it is due to the lack of an over-all view of the airplane. But I ascertain, by the effect that it produces on me and on the others who have seen it, that it is better than the pictures. After all, that doesn't matter. Let's enumerate its faults.

The faults are numerous. It is a composite of errors. Still I did approach the goal, but I strongly believe I missed it. The carriage is too heavy and in spite of its weight it is too weak. The springs of the wheels that are visible in No. 2 permit by means of their horizontal disposition a movement in the plumb of the wheels that seems dangerous to me. The tests will show their value. Since they were completed, I have found out a much better arrangement, but the work was all finished. I believe that the wheels of a strong tandem bicycle would be much lighter and infinitely better than our ugly wooden wheels, even though they are a masterpiece of an Italian specialist in Cairo.

The screw is too short, and not strong enough, etc. etc. It seems to me that I see in this the prototype of the bicycles. If it wasn't forbidden by the first idea which is based on just two ideas, immutable, that are the two directions, one would want to run away. And still all these mistakes are only errors in details. The construction of the whole has not yielded. It is heavily and clumsily made but anyhow it will do there perhaps not with this machine, but with his newer relative, more carefully made where one will have dispensed with a collection of kilos, although making it at the same time more solid.

At last the wings. The bamboos are as thick as this pencil-line. This line is the transferred design of their segment. I put the sawed bamboo on the paper and make all around a line with the pencil. I believed that in using these monsters I would exaggerate a great deal the necessary strength; well, I was probably mistaken. I am very much afraid that this will not carry me. As there is no table of resistance for bamboo, I can be exceeded; nobody knows more about it, it will have to be tried out one of these days, but I confess frankly that I am afraid. And still, who could have guessed! The only things that I judge to be sufficient are the enormous hinges, visible in No. 1, and still I can see them more perfect in my mind. There again we can pare down; save weight and add strength. One must cheat a little, that means using strings or wires, making buttresses, a thing that I have avoided in this airplane. But by cheating a little, what strength one would gain. But on the other hand, how much would one lose in penetration? The tubes that seem to be fixed by means of the front wheel on one part and by the large bamboos on the other are also an improvement to this principle not to fret any bar, any wind-cutter across; but I was forced to do it in order to help the two large bamboos. Perhaps I exaggerate the importance of this action of the cables that act as wind-cutters; the operators that fly have none and I have heard the song that they produce when they are exposed to the least draft, in spite of being so thin, and I told myself that such a vibration would also produce such an effect. After having said everything bad that is possible to say about this poor airplane, one shouldn't condemn it before having seen it work. I still have to cover it and to furnish it with carrying surfaces the whole empty part through which one sees the undercarriage. That will make so many more supports. Then cut everything that goes above the indispensable. There will still be a few kilogrammes gained, and finally transport the whole thing to the desert. That will be for next week.

In Cairo two things are good; the bamboos and the desert for the experiments. It is large and one is not bothering people nor bothered by them. But for all the rest, what a dearth of all things, what a complete scarcity of all things necessary for construction. One should bring from Alger or from Cairo a provision of very large, giant bamboos and a collection of small bamboos. Cairo is somewhat exhausted; Alger and its experimental garden is infinitely better provided, and from there go to Paris for the construction. In Paris one finds everything, workmen and fabricated material. Imagine that - there is not one steel tube in Cairo, etc. and so it goes with everything. Certainly, in order to succeed one should have this: proceed on a larger scale, be able to construct at the same time different variations of the same model, choose the best one, perfect it, reconstruct it even; one shouldn't think that in such a difficult undertaking one could hope to arrive at perfection at once. As far as I am

concerned, I am convinced of the goodness of the principle. I am not in doubt about the maneuvers of the flight; I have seen them demonstrated enough during long years before my eyes in order to know them and especially to have understood them, and to give over my person there. That is not the difficulty for me. It is on the contrary the simple details of construction that a well-equipped bicycle mechanic could overcome in a month very easily. It is simply the doings that I have been missing and that had to be. I was in a bad position to construct. Well, we will see that one of these days, but I am very much afraid that it will not carry. I should indeed have used much stronger bamboos. There are some to be found.

Tomorrow I will, moreover, decide this case by a direct experiment. I shall take four stevedores. I shall go into the undercarriage as shown in photo No. 2 and the men will try to carry me away by putting me at the points indicated by this sign in photo No. 1, the place where probably the center of connection of the wing will be placed. If the plane breaks, that will be the end; if it resists, so much the better, it will go to the desert. In any case I believe that elementary prudence demands to try the airplane out before embarking on it.

I look over these pictures and I realize that for anybody who has not the airplane to look at, a view of the whole is missing, that such a view must be added. I will sketch it for you one of these days.

As this letter will reach you around New Year's day, I am going to wish you and your family the best wishes for a happy new year.

Affectionately,
Devotedly,

Mouillard

Cairo
December 15, 1895

Mr. O. Chanute

My Dear Sir,

I am answering your kind letter of November 27, 1895 which tells me that I almost had a chance to see you.

I thank you with all my heart for the share in Lilienthal's patent of which you will let me have one half. There must be some good necessarily in his way of interpreting this problem riddled with difficulties. It would have to be seen and to be studied, take the good and leave the bad.

In my last letter I spoke to you, while criticizing my airplane, how I was afraid that it would break at the hinges. I tried it the day before yesterday. Four strong stevedors were placed two by two at the end of each big bamboo and carried the empty undercarriage. The arms did their duty without effort. Then I decided to go all the way; I sat myself in the undercarriage. I was carried without producing hardly any sagging. Seeing that it went so much better than I had hoped, I told my aide to climb in with me (with precaution). These four strong bamboos behaved admirably. They deflected, but in a normal way under this weight of my aide (65 kg), myself 53 kg and itself about 100 kg, a total of 220 kg. We stayed carried up like that at 0.35 m from the ground for five minutes. Useless to tell you how happy I was. My nightmare had vanished. Now remains the incline to the right of the undercarriage, which is very feeble, but this one if it breaks, it will happen when it reaches the ground; that has less danger. At this moment I am finishing putting the tail in order and some annexes of the carrying surface; that should fill up this large void that goes around the undercarriage - see photo No. 2 that shows the airplane looks from behind.

As I see that some time or other you will get to Paris, without telling one in advance, I take a jump ahead and take the liberty of giving you the address of the fraction of my family who lives in the Capital. I am happy to show you to whom I am related. I have also a beloved niece and her husband living in Nice. If your brother-in-law would give them this card, I'd appreciate it.

I have nothing to say about the cholera; always two cases a day on the coast, 52 miles from Cairo.

Affectionately and always devotedly

Mouillard

December 31, 1895

Mr. L. P. Mouillard

My Dear Sir,

I received your letter of the 7th and I can at last judge your airplane by myself. I think that you made it too big and too heavy, and that you copied the bird too closely.

It remains to be seen what the experiment will indicate. Don't get discouraged too soon, but be careful that you don't get hurt. I hope that you are following at this moment the program that you indicated in your "Flight Without Flapping" in order to avoid accidents, and I'll be anxious to hear from you.

I cannot figure out the mechanism from the photos. There should be, as you say, a drawing in order to understand it.

Still, that is not so important, the essential thing is to know if your invention will give you the two controls of direction and equilibrium. I wish you every success and I beg you to keep me informed of your experiments. May the year 1896 be happy for you.

I shake hands with you cordially.

O. Chanute

Cairo
January 5, 1896

Mr. O. Chanute, Engineer
Chicago

Very Dear Sir,

I have just spent about a week in the desert and am now back in Cairo by reason of damages and repairs to the aeroplane. I sent the machine into the desert and tested the action of the wind upon those surfaces which at first sight appeared enormous. I released this great monster down a slope of 5% and, despite a wind from the south with a speed which I estimate at least 10 meters per second, no significant rise was obtained. From time to time the marks of the wheels would disappear and I would feel that they were no longer turning, but these moments were so minimal as to be despaired of. I scoffed at myself and at the precautions I was taking in order that the aeroplane might not be borne away at night by some sudden gust of wind, precautions which went as far as burying the undercarriage and covering the wings with stones and sand, and I told myself that all this was very silly.

Thus, excited by these continual failures, I reached such a state of exasperation that I no longer had faith in the correctness of my observations or in the figures in the tables of the studies of birds in my book. However, as I had been accurate, I well recalled having taken the greatest care in working them up. Mr. Drzewiecki on his trip to Cairo looked over and recalculated several which he found absolutely accurate; and still no serious flight!

Absolutely furious, I tried it without the weight of my person; it performed in just about the same way. On 3 January there was a wind, still the Medare, from the south, cold, with a speed of at least 21 meters. I decided to risk losing the machine and launch it in this fearful stream of air. It took six men to move it. At one moment all six of us were knocked over and caught under the machine. As it is not heavy, 100 odd kilos, no one was hurt. We righted it, joking about its flying whims, and set out carrying it again to try it on a selected slope, the outline of which is given below:

We arrived at X. When we came to A, I had a strong cord, about as thick as a stalk of wheat, added to the front and held by my aide at C for the purpose of steadying it and keeping it headed in the right direction into the wind. Then, with two men holding the tips of the wings and 5 or 6 others pushing from behind, it

was launched down the slope. At B, the front, raised by this little earthwork, was caught by the wind. The aeroplane rose, ascended to a height of 8 to 10 meters (a second stage), became motionless in spite of the cord (my aide, completely hypnotized by the sight, forgot to pull). The aeroplane began to move slightly sidewise to the right, came down again very slowly, and sat down on the ground so gently that nothing was broken. Later it was learned that one of the springs of the front wheel had broken at a point where a large bolt passes through it to hold it in place, which prevented continuing the experiment. I had wanted to make it pass point D and to see it enter the void DE, which extended indefinitely. This experiment does not demonstrate very much. However, it was so pretty that the spectators - there were about twenty persons present - could not keep from uttering cries at the slowness and majesty of the movement. You may judge of the slowness. The machine covered a forward course of no more than exactly 28 meters and stayed in the air for more than 1 minute. I repeat, this is only of interest as a lesson, but it proves: (1) That the wind supports. We knew that already. (2) That it is madness to dream of submitting oneself to a wind of such velocity; and that, above all, for the first experiments, it is necessary to proceed in an almost absolute calm; and that a still greater surface is required. The machine suffered in no respect (the strength of the bamboo is remarkable), the tips of the wings, their edges, bore the machine and my person twenty different times; they are still as new as before the experimentation. I am going by additions to enlarge this surface greatly, adding to it simply very thin, resilient bamboos, 0.015 in diameter, and light linen coverings. The weight will be increased by only 5 kg and the surface extended by from 5 to 10 square meters. I will change the location of experimenting, and will try out a much more abrupt slope that I know of, and will begin by falling, to accustom myself to the void, and will only pass to rising from the flat, using the current of the air, when I shall be absolutely sure of myself and of the good functioning of my aeroplane.

I have not been satisfied, among other things, with the controlling action of my moving planes (annularies) at the tips of the wings. I must greatly increase their importance. This device is indispensable. It was their absence which prevented Lilienthal from going farther; it is this which permits going to left and right.

I am leaving this evening to look for the machine in the desert. It will take about two weeks to make the repairs. The new experiment will therefore be at about the end of January.

I am writing of this experiment with a wealth of detail, not because I attach the least importance to it, but only because there were quite a few witnesses. False rumors will spring up and exaggerate a great deal the course of events.

There still remains at least one defect in this machine that prevents its being practical. It is that of having to remain in repose with its wings opened, and the consequent necessity of watching it constantly so as not to see it blown away at the first gust of wind. It should be changed so that, at rest, the covering would be capable of folding, disappearing, of offering no, or almost no, resistance to the wind. I have this system in my head, but it would take long to make and would be expensive. Finally, if the present aeroplane, modified, should happen to produce something of which one might boast, I am hoping that by means of a group of the friends of aviation it would be possible to build it.

You have already spoken of this combination; it therefore seems feasible to me. It is a question first of producing a serious flight.

Mouillard

Cairo
January 25, 1896

Mr. O. Chanute
Chicago

My Dear Sir,

I received your kind letter of December 31 and good wishes of success that it enclosed, for which I thank you heartily. You must have a new letter from me telling you about an experiment of the taking-off of the pilotless airplane, which is rather interesting. Since then, because of repairs, the airplane has been taken down to Cairo, and fate willed it that I haven't had time to work on it. I am a struggling herborist now for a fortnight, in spite of myself. I was obliged to substitute for the lady who keeps the shop that we own, but she will soon be back and I will begin with these repairs and this enlargement of surface, which is indispensable in order to get carried by a medium air current, meaning 10 m to the second, or in falling down to fall slowly enough so that I wouldn't get broken up. Ten kg of load to the square meter of surface are too much for the first studies, certainly it is double what is necessary for with this load there must be a frightening speed that would scare you. The tests must be made in a weak wind and not with a wind of 40 meters which would even have been insufficient to carry me. As you see, we do not agree with Lilienthal; which of the two will be right? The test will tell, but already one can explain this disagreement. He proceeds by falls; it is the animated parachute that he studies. For me it is different, it is from the first the direct take-off and the penetration that has been perfectly indicated in the experiment of which I spoke in my last letter.

Allow me to change the subject for a moment, for in aviation at the point where we are now, we need facts and not speeches. You wrote me at the time when I submitted to you my two torpedoes that the United States was in peace with everybody and that by this fact my ideas were not suited to the situation. Today the conditions are not the same anymore; don't you think like I do? This reasoning that was perfect two years ago is no longer so at this hour, where you are up against a naval force of the first order, especially formidable through the number of its regular units, eager for combat. (England is so far ahead of us that it would be hard for us to catch up, not on account of the money but the time needed to be able to produce a navy.)

Don't you think that it would be feasible to present at this time these engines of a fighting quality different from the ordinary battleship? They are engines that do not cost much and can be produced in great numbers in very little time. I stopped talking to you about them at the time, because it wasn't the moment to produce them, not on account of the objections that were made against them - that of the destruction of the carrying conveyance by the repercussion of the shock in the water. This destruction will be avoided very simply by the elasticity of the outer coating. The objection to the lack in direction in both torpedoes is answered by the action of the rudders, which give a precise wake, stop, and heading in the right direction, and made in such a way as not to miss a boat 100 meters long when they are launched a distance of 100 meters from the goal; this distance is sufficient to lessen the commotion however terrible it may be.

So I beg you to choose an instant when you are not too preoccupied and to read over with attention my communication on this subject and to judge if it should be possible to conduct some experiments that would prove their worth.

I was often obliged to think on the fate of the carrying conveyance, especially for a case much worse than the one of pulverization (pardon this expression) of a common battleship; it is that of the destruction of a naval base by the simple action of vibration. I think that even in these extreme cases the carrying conveyance would not be in much danger.

It is in order to talk to you about these things that I would have liked so much to see you. In a few hours of conversation one says much more than in volumes of correspondence.

In spite of the enormity that one would notice at first sight in the above paragraph, I think certainly you are already persuaded that I do not wish the death of anybody. Still I think that the economy of time, money, work, etc. are things to be considered, and the more destructive the war weapons will be, the fewer men will be killed. It will be, if you want it like that, forced, but as I have been able to analyze to you from afar it will certainly not displease you.

Handshake and devotedly

Mouillard

Mobile
January 28, 1896

Mr. L. P. Mouillard

Dear Sir,

I have just received your letter of the 5th, and I am afraid an accident might happen to you with your enlarged surfaces. They have already the proportions that Lilienthal indicates as a prudent limit, and if a gust of wind happens to come you will be thrown over with your enlarged surfaces. It is preferable to turn your wings over on the wrong side.

When I received your photos I thought that you had turned your wings wrong side out in order to mislead the indiscrete, and that you would explain that to me in your next letter. If that isn't so, and if you have exposed the convex side to the wind, it is not to be wondered that the effect was minimal. In offering the concave side, you would double the effect. The experiments prove that the upper surface must be launched, and that the body must be beneath.

I received your letter of December 16 with the cards of introduction that you were so kind to send. My brother-in-law has left Nice, but as it is possible that he may go to Egypt, I will give him in that case a letter for you. His health makes very slow progress and he believes it necessary to have a doctor constantly with him. If he goes to Cairo, he will write to you by mail, and I would beg you to call on him. Neither he nor his wife speak French, but they will have an interpreter with them.

I wish you good luck in your next experiment and I will be anxious to know the results.

I shake hands affectionately

O. Chanute

Cairo
March 24, 1896

Mr. O. Chanute

My Dear Sir,

I have received your kind letter from Mobile. You have a talent of going from one place to another that always confounds me, you change from Chicago to California, from California to Florida, as we go from one part of the town to another. You survive the railway fever as I survive that of the boat. Maybe your railways are more comfortable than ours, for ours, and by that I say those of old Europe, are so enervating that, as for me, I prefer to have an eight-day sea voyage rather than 24 hours railroad. After all, you have perhaps only steadier nerves than we have.

What beautiful things have you seen in Florida? I hope you will be kind enough to tell me. I know that there are pelicans and especially frigates, two beautiful sailing masters that an aviator must study, especially the latter bird that I don't know and that must be of great interest for the flying procedure. In the last no. of the "Aeronaute" there are a few words on his account that I don't believe: the night or nights spent in the air. This tale is a little tall for me to believe.

I hope that you will put this right. You will probably have the opportunity to give precise information on this.

As for me, I am resting at the moment. I am at a deadlock as they say in mechanics; half of a failure on one side, slight sickness on the other, worries of all kinds, in the end forced necessity to go back to the office to make the pot boil, for alas, I am at the end of my rope; all that holds me down. Still, I haven't burned my airplane yet; on the contrary, it is nearly finished to 4/5. The surface is now, I hope, large enough. Each square meter has now only to carry 4 kg. I am furious with myself that I have not more life in me to be childishly stopped by details, for after all, it was very beautiful in the air at the height of a house and especially well balanced. The majesty of its bearing was nameless; to get to that effect to make the Arabs cry out loud; frankly this bearing must have been astonishing, for this race is not more easily astonished than snails. In fact I think, and this is the worst, that I can do infinitely better than what I have done and this is what discourages me so much. I have not made an error in theory, even by putting the body of the wing above (I could not convince myself that I was mistaken there, for small airplanes function as well with the body above as with below). Nature hasn't decided this case once and for all, but it has frankly skirted it in the bats where the skeleton of the wings, the bones, are neither below nor above, but in the carrying membrane.

I believe that in order to arrive safely one must not think of producing at first sight a marvel. One should be able to produce different models, be able to improve, be able in a word to progress. Not in theory, no, for that is correct, but in practice. One should be supported by a group, the more impersonal and powerful one possible, rather than by one individual, no matter how good and charming. This individual, like you my dear sir, who precisely through your kindness makes one afraid to DARE. It causes one to hesitate and be held back by discretion so as not to make the same mistake as he did about the aluminum and even not to start over again.

You, who are in a position to form a group, create one please! You would get me out of the worry to think that I play with your money, you would allow me to dare, as I have said before, for I have the absolute conviction that I am only two steps from the kilometer covered in the air, that the details are at fault and not the idea, that silk is needed instead of cotton, steel wire instead of soft iron, an under-carriage and a mounting in steel tube instead of his tabernacle in wood and my wooden cart, wheels, in fact, that one can save half of the weight only in doing better all over again. Then one should be able to go ahead much quicker in the construction than I am going in construction, speeding up the stages, make the airplane in three months, all finished and tried out besides.

Don't you believe that the torpedoes could help the airplane? You are, I believe, nearing more and more a naval war, and not precisely with England, but with Spain. This idea of the torpedoes is a harbor where I cannot enter. Still it is as right as that of the aviation, the shock. Surely I never had the opportunity to try it out, but it is something so easily done without risking anything, and done practically without risking even the shadow of a wound for the experimenter if he stands at a little distance to the point where the explosion is produced. It is evident that at a distance of one kilometer it will not be felt. At 500 meters one may have an idea, by the noise, but not by the shock received, that at 400, 300, 200, one will feel it progressively. That at 100 meters distance that I indicate, it will not be fatal, and that closer one will endure the more easily, the less one is in contact with water. It is clear that if the torpedo jumps naked into the water, the force of the shock received will be in proportion to the proximity, but if instead of being naked, it is clothed with a series of horsehair vestments wrapped with rubber, it is allowed to believe that the shock will be bearable even from very near. Then one must not speak any longer about 100 m of distance, but perhaps of less than 50 meters. Certainly the experimentation will prove what I am saying or else it is no longer permitted to sew two ideas together. When it will have been tested, and it doesn't cost much, 200 or 300 kg of dynamite will be enough for these practical experiments, one will think then that at a 1/20th of time and 1/100 of capital, all the navies will be equal.

These ideas are so simple, that I see against them, as an obstacle, only the opposition made by those who have acquired positions. Certainly the Staffs of the Navy will not be in favor of this order of ideas, no more than for any other novelty, the Staff in every Navy is still with the sailship; however, they did get accustomed, one must acknowledge, forcibly to the battleship, but as soon as one speaks about pulverizing to the battleship, nothing goes anymore. In your country as everywhere there will be opposition, but I count on the war of the minds in the U.S.A. to force the hand of these retarded Naval officers.

Devotedly

Mouillard

April 15, 1896

My Dear Mr. Mouillard

I have just received your kind letter of March 24. I have attentively reviewed these last days your project of a torpedo. It seems to me more difficult to place than that of the airplane. The first idea has already been presented to the officers of our navy in 1892 by Mr. Vogt of Copenhagen, and had been dismissed. The only chance that I see of getting money out of it is to wait for the war and to make a contract with the state to destroy the enemy battleships at the rate of 50 frs a ton, paying all the expenses and keeping one's secret. For that, there has to be a war, and the American, English and Spanish boasters haven't got that far yet.

No. One thing at a time. Let's stay with the airplane. The idea of forming a group doesn't appeal to me. I'd prefer spending my money rather than that of the others, for a machine that has given a half failure and that I do not understand well; for the photos that you sent me, instead of drawings, give only a vague idea of the construction. Moreover, I see that you didn't understand me. I really believe that the body must be put below but it is especially the concavity that I believe must be put underneath. That will quadruple the carrying force.

In the present circumstances, this is what I believe must be done: Go to the English officers who are taking part in the expedition to the Soudan. Tell them that you have a draft of an airplane that could be useful in the campaign and ask them to obtain for you a paid leave of absence at the ministere and a discrete platoon of men to make the first tests. Ask them for secrecy so as not to compromise your interests in the case of a partial success.

I received a few days ago a letter from the Pittsburgh Aluminum Co. saying that they had sent you their bill a year ago, leaving a balance of 250 frs for the aluminum, and that it wasn't paid. I sent the sum, having offered to you some time ago to pay it, but having received no answer from you. If you have already sent the money, let me know.

My wife was sick in Florida and I hardly saw anything of the gliding birds.

I shake your hand

O. Chanute

Cairo
May 8, 1896

Mr. O. Chanute

My Dear Sir,

I read over your kind letter of April 15 and find there a passage that makes me go through all the colors of the rainbow; it's the last one. I must have made a curious impression on you. What must you think of me? The Aluminum Co. has been paid by me of his bill of 250 frs. After receiving your letter I went to the bank Credit Lyonnais and asked them to look up at what date I sent a letter of credit of 250 frs drawn up to themselves, office of Paris. They told me that I had the sum debited September 21, 1894. It is not to the order of the Pittsburgh Co. but on sight to themselves and I remember that they told me that it was the best way to proceed, that the negotiation of this letter of credit could be made easily everywhere. I remember perfectly that I wrote to the Co. in Pittsburgh at that time and that I paid them. Besides, I had nothing else to write about to them. As that wasn't enough for me, I asked them to write to Paris and to see in the General Bookkeeping if this letter of credit to themselves had been paid and to whom. I wait for the answer from Paris, and as soon as I get it, I'll transmit it to you; it will be in a fortnight, I believe.

For now, let's change the subject. My poor torpedoes are not to your taste; still I believe that without the surfaces they have some merit. It is certainly daring to embark on a jet but is it more so than a number of exercises that are practised daily, the bicycle, the trapeze, the rope dance? I should explain it to you myself. There is here a radical reform of all that has been established in the Navy, and the sailors do not want to go through with it. They will only submit when they will have to fight against these gadgets. But it seems in my conscience that it is up to them to do it and not me. I don't wish at all to kill the enemies of the U.S. If they were those of France, I could think it over and be tempted to do it; but except this special case I must not do it in person. Certainly the art of aviation is more seemly. I don't think of stealing anything from anybody nor do damage to anyone; there would only be the case of self-defense that would make me use these means. After all, the older I get, the softer I get. Is it bad? Surely not. I subscribe as much as you want to, to put the body of the wings below, that is not so important. As to the question of concavity more or less accentuated, that is another matter. The concavity (below) in my airplane will not be greater than that of the large vulture, my model. I can have faith in him. My airplane is still at the convent. I hope to be able to live there. It would already be better than what I have now; but what I dream of is better yet. It is to go and live on the testing grounds, be able to experiment every moment and not be obliged to walk 4 km to go and as much to return, and at the same time to hold my job at the ministere.

I am thinking this project over and as soon as I have found a solution I'll tell you again. Still this special habitation will not be sufficient. More and more I am convinced that another airplane should be constructed, better and especially lighter. I shall keep the old one but don't dare to rely on it absolutely. This large weight will cause some mishaps. I hope that Madame Chanute has recovered from her indisposition and I wish her good health. In order to see the glider flight, dear Sir, there is decidedly only Cairo. My crows and my kites are swearing at me and certainly at you too, at this moment because I am writing my letter too close to their drinking place. I am 1.50 m from their plate. Still they are making up their mind.

I am affectionately yours

Mouillard

Cairo
June 5, 1896

Mr. O. Chanute
Chicago

My Dear Sir,

Here is the information that the Credit Lyonnais transmits to me on the peregrinations of the credit letter of 250 frs. that was to pay for the aluminum from the Pittsburgh factory that furnished me this metal.

Order O. Chanute - Endorsed by O. Chanute in
Pittsburgh Reduction and Co.
Passed to Toulon Anson, to Abraham Chipley
who cashed it himself in Paris.
(Mr. Chipley is the correspondent of the
Credit Lyonnais.)

Out of all these endorsements it comes out that I paid to you; I had forgotten that entirely, and you also, it seems. So you have certainly paid the Aluminum Co., the details furnished by the Credit Lyonnais are proof of it.

The one who is in the wrong in this mix-up is the factory which asks twice what has already been paid once. So it seems to me that this question is settled.

Dear Sir, I read in the French papers that Mr. Langley is supposed to have tried his airplane and succeeded in flying. What is true in that report? To what extent is it true? To figure out, to indicate the possibility of carrying oneself in the air doesn't mean flying. For myself, I have already several times produced this demonstration: 42 meters in Algeria, and in these days several small carryings of which I don't dare to speak because of their short duration, but in which the wheels of the chariot not leaving any traces in the sand seem to indicate by this lack of traces that the air sustained the plane and my person.

It is not that which is needed, nor the falls of Lilienthal, but the real run to the hundred kilometers, the real flight in one word. All that has been done for twenty years is simulated flight and nothing else. The meters run, in more or less great numbers, also simulated flight, magician's trick, unless that by their quantity they would really prove a flight: as for example, the hundred I just spoke about awhile ago from Cairo to Suez, for example, but all these little flights don't prove much; witness Lilienthal who stops on the way and sells parachutes. You are perfectly well placed to know what happened in Washington; please let me know.

The airplane is still at the convent. It needs a slight going-over, but it isn't that what worries me much. I am obliged to leave it there at rest until better times will allow me to do it over again, better made, lighter, more perfected and especially to find a place where I can try it out every day. I believe the last point to be very essential. When I make it over I shall have it remade in Paris, for I see that it is impossible to construct it in Cairo. It would even be convenient if I could spend some time in Paris to superintend the construction and only have to mount it on bamboos which cannot be found in Paris.

I have lacked all this time, for a year at least, the incentive that arouses the aviator, the exciting stimulant that always had the greatest effect upon me. I want to speak about the flight of the great vultures, these birds that show you that flying is possible, that one doesn't pursue an idle dream. I no longer see any. The kites make me go to sleep. I tell myself it is so difficult to reproduce this flight, that it is better to wait until "I become young again," and I wait; I think of the future, of finding a secure position for myself. I postulate some easy job where one lets oneself go and I forget the problem of my whole life. I believe I must take advantage of my last beautiful days. I feel fine. I must make use of it to make the supreme effort. After all, I don't believe much in the success of Mr. Langley. Success at the first trial seems to demand an explicit demonstration. For myself, that hasn't been my fate. I am constructing the eighth airplane. I see that I am nearing the goal but I find also that I have to improve and that what I leave behind can be perfected.

This is simply, dear Sir, what I am thinking of. I do not hope less than at the time when I wrote "L'Empire de l'Air" and "Le Vol sans Battement." There is a last great effort to be made and I really want to make it.

Devotedly

Mouillard

Chicago
June 8, 1896

Mr. L. P. Mouillard

My Dear Sir,

I received your kind letter of May 8. Thinking that perhaps there had been made an error in Pittsburgh, I wrote to the company and I send you their answer. The credit letter of September 21, 1894 has been received through me, October 13, 1894, but it paid only for half of the aluminum. The company sent you their account January 5, 1895, showing a balance of \$47.17 dollars, and I wrote from New York around January 10 offering to pay the rest if you couldn't do it. Getting no answer from you on this subject, I believed that you had paid, but I see that you mixed up the 250 frs sent with the order with the rest of the account of 250 frs still owing.

One passage of your letter surprised me. You say: "The concavity (from below) in my airplane will not exceed that of its model, the big vulture."

So it is an error in photography, for the three photographs gave me the idea that your airplane is convex from below, and concave from above, and I thought that you put it wrong side up on the body to mislead the indiscrete ones.

You must have seen in the "Aeronautical Annual" that I sent you that Lilienthal makes great progress. By superimposing his surfaces, he succeeds in maneuvering them much more easily, and having studied the gliding flight of the stork last summer, he hopes to imitate it entirely this summer. I sent you also a paper giving the description of the tests of Langley's airplane that has made a run of about 2 km by steam. You will see the details in French in the "Comptes Rendus."

I shake hands

O. Chanute

June 22, 1896

My Dear Mr. Mouillard,

I received your letter of June 5. You must have seen, by mine of the 8 that you mixed up the remainder of the account of 250 frs from your second order of aluminum, with the 250 frs that you sent, approximately, at first. It is this sum that I had offered to you to pay and that I paid with interest of one year.

I sent you a paper with the reports of the tests of Langley. You'll see them in French in the "Comptes Rendus." It was a machine with four wings of 4.27 meters of spread, weighing 11.8 kg with a steam engine and two propellers. He flew twice in calm weather, about 1 km in spirals, rising 30 m and coming down slowly, by gravity. As you say, it isn't yet the flight, but this indicates the possibility of it with a steam engine. Mr. Langley is in bad health and cannot at present continue his experiments. So you still have the chance to be the first to make the flight of 100 km of which you speak.

I have myself started preliminary experiments to dig at the bottom of the problem of equilibrium in the wind. I have had two machines constructed, one like Lilienthal's (15 kg) and the other my invention (17 kg). Mine has 12 wings that one can group in different ways, and I am looking for the arrangement that will give the greatest stability and the best support. Lilienthal's machine is not stable. At every moment one has to make gymnastics. We have experimented with it for 3 days and we have obtained runs of 30 m. in going down 6 to 8 m. We only obtained 9 m. from the other machine by going down 3 m. because we do not dare to launch ourselves before knowing if all the parts are strong enough. I know already that this machine is more stable than Lilienthal's, but I don't know if it will be able to fly. Later, if the experiments give an indication of the possibility, I will order the construction of a machine for running and I'd be happy to receive your advice on the way to go about it without breaking one's neck. I have with me a Mr. Herring who served Mr. Langley and a carpenter who worked at the construction of the machines. It is because, in fact, I intended to order the construction, as I wrote you, that I did not insist on finding out the details of your own machine, as you had promised at the beginning, and that I sent you the picture of the first model that I had made with multiple wings.

Cordially

O. Chanute

Cairo
September 14, 1896

Mr. O. Chanute
Chicago

My Dear Sir,

At last this diabolical summer is nearly over. The centigrade thermometer rose up to 35 - 40° from noon to 5 o'clock in the evening, and that during long months. And it isn't over yet because we have still all September that can have in store for us very ugly days.

I admired this summer the kites that from 9 o'clock in the morning, dinner over, hurried to rise as high as possible, in order to avoid the oven, and came down only when night and calm air were reestablished. I had nothing but worries this summer. I dismantled my airplane which I had enlarged. I hoped to be able to pass it through the neighbor's place, but it won't go through. So I have been forced, in order to avoid paying the rent, to partly dismantle the wings and to bring it back to the house.

I made up my mind because, although this machine has many qualities, it is so heavy in all its parts, that frankly it is to be made over better than it is now, and it will be easy. It is to be gone over in all its parts. The wings can be solidly fastened with the given weight that they have. The landing gear is to be preserved in a museum as a specimen, as an ancestor. The mechanism of the screw, although it is right, must be made over in another manner. The directing planes are insufficient; one must make them more perfect, more active. There is too much iron and iron is heavy! In short, there are many good things, and even in great number, for it holds up marvellously in the air; it possesses a brash equilibrium, but it has to be remade more finely and at the same time more solidly.

In dismantling it, I learned a series of good lessons. I have seen the points where I put an excess of useless weight and strength, and they are numerous. There is much to be gained for lightness while making it more solid. In short, do better. I read in the newspapers that Lilienthal killed himself. How could he trust himself on a machine as unstable as his? I was never able to understand it completely in spite of the good enlarged photos that you had sent me. The forward position of the wings to produce vertical equilibrium I didn't find satisfactory. The screw of my machine, although it is strong, is not entirely satisfactory to me. It is somewhat weak and its action is too slow. It has to be longer and stronger. It functions, but one could do better by means of levers activated by the total weight of the aviator. I have this device already in my head, but one must think it over a long time before deciding to put it in the work-shop.

This death is certainly a great loss for aviation. How the ballooners will get swollen heads; nobody will be worth anything but them. They, and they alone, will have the right to speak. Still, ~~there~~ there was so much good in this airplane of Lilienthal's that he flew. I'd have liked to know this man and especially the machine he used. Perhaps this flying machine lacked one little thing that he didn't see and that somebody else would have found at once ; and humanity would have had wings! This death will probably be a setback of a hundred years for the people of the world. Maybe more. Maybe less. Well, as far as I am concerned, I can't do anything right now for one has to try out a great deal in order to succeed in something, and to try to do it over, do better than has been done; one needs gold and for a long time I haven't had so little of it as now. It is probable that we may die without having tasted this gliding which is so sweet, of such strange voluptuousness that I have perceived during a few meters only and still could never forget.

I hope that the magazine "L'Aeronaute" will give us the clue to this misfortune, that Lilienthal's brother, who assisted him in his experiments, will describe to us the maneuver which was badly performed and caused his death and that out of this failure of the maneuver will be derived a very useful lesson for those who wish to launch into the experiences of aviation. As for me, I should like to produce a machine whose motion and equilibrium in the air would be automatic in a medium air current. That is why the last experiment was made without the weight of the aviator. I succeeded with this translation against a wind of 10 meters to the second at least without the most perfect equilibrium with such a perfection that the Arab spectators who helped me with the maneuvers were positively overwhelmed. There were cries of "bravo" shouts to make you run. Then, when there was a lull, majestically and slowly, not even breaking one single thread, the view of this take-off and landing gave to those people, who have only commonsense to take the place of knowledge, the certainty that this study, the possibility of aviation, was resolved once and for all. They wanted me to start again this experiment right then and there with my person in the airplane to direct it. Then I began to make a very thorough examination of the machine and I found that, in spite of the softness of this landing, the front wheel had weakened in one of its springs, it had to be repaired; moreover that the air current necessary for this departure was very strong, that it was necessary to offer more surface to the action of the wind. So I decided to take this machine back to Cairo and to begin with the necessary repairs, which has been done. But there happened this grotesque situation that I couldn't get out anymore from any side and that I was in a cage. So I have to do better there too. I must choose with greater care the place for the experiment, take a more practical point. I had thought about such a place. I even told you about it, and I didn't take it. It is Helouan, the city of Bain, a town situated to the south of Cairo in the midst of the desert, one hour's train ride from here. I would have been so much better there to make my experiments than at Mokattam but I didn't dare, on account of the expense. There are all the desirable slopes and even all the

perpendiculars one can wish for. Everything is there, a comfortable city, doctors, a railroad, buildings that seem to be constructed especially to house the airplane and that open directly into the endless desert and all that only one hour from Cairo, near enough so that I can go on with my government job. If I reconstruct, I intend to replace the undercarriage by a strong bicycle weighing 25 kg, strong enough to carry a man who weighs more than 100 kg, to replace the whole mechanism made of iron that fastened the wings by 4 strong wires, the steel frame of the wings by a similar lighter one. The other would be used as a model. If the lever that I imagine to speed up the transmission in front or in back of the wings doesn't satisfy me, I will make over the screw, better and just as light. There will be great changes in the wings: (1) silk everywhere and (2) an additional variation of surface. This surface is important when the points are put in the back, like the bird's wing. But that is fine mechanics that calls for the mechanical hands in Paris. Therefore I must stay a few months in Paris with my friend Jobert who is a specialist in aviation mechanics. Then I have to carry back everything to Helouan; there it has to be mounted, tried out, but above all not do it like Lilienthal. You see, what I propose to do is some kind of a wonder.

I shake hands, always devotedly

Mouillard

October 16, 1896

Mr. L. P. Mouillard

My Dear Sir,

I am very much relieved by your letter of September 14, for having received no answer to my two letters of 8 and 29 June and having seen in the "France Aérienne" of August 1 that Mr. Huard talked about you as "Mouillard, the regretted Mouillard, who had learned so much through observation in Egypt and in Algeria, etc. etc.", I had made for myself the saddest suppositions. I am happy that it is not so.

But allow me to observe that you should have answered me inasmuch as my letters referred to a money question, and that I had a certain interest to know what had happened to a machine that cost me more than 3000 frs.

I regret that you have dismounted it without having made a serious experiment, for, be it ever so heavy and imperfect, it would have indicated if one could expect gliding flight from it. If it doesn't permit it, it would be of little use to make another lighter and finer machine.

I believe that I am justified in speaking about serious experiments, for this summer I have tested five gliders of natural size. First the Lilienthal (photo no. 1) weighing 16 kg, that I found soon to be very unstable, and have abandoned after about 100 glidings. Then my first machine (no. 2) weighing 17 kg that made about 150 glidings of 10 to 30 m. in June and July. Then I reconstructed it in two different ways, no. 3, 14 kg, that made flights of about 60 m. and no. 4, 11 kg that made 100 m. Not only one gliding, but hundreds of glidings of 40 to 110 meters in the desert of sand dunes where we retired.

The newspaper discovered us finally and they published a number of articles more or less full of errors, especially on machine no. 5, big airplane constructed by a Russian sailor and weighing 90 kg. This one needed an inclined plane in order to start off. You will see it in profile in the background of no. 4, and more in detail in no. 5. We launched the apparatus twice, loaded with 60 kg of sand, and although it was damaged, the aviator would not have been hurt at all if he had climbed into it. I am sending you a few newspapers. We had to stop on account of bad weather, but we will begin again next summer. We made hundreds of glidings in the air, but no sailing flight, although we have been often lifted up from 10 to 17 meters by the wind.

Not the slightest accident has happened to anyone.

Sincerely

O. Chanute

Cairo
December 10, 1896

Mr. O. Chanute
Chicago

My Dear Sir,

I have to answer two of your kind letters. In the first one was one word that struck me. It is that of a publicist who said that I had killed myself. "This poor Mouillard who is said to have lost his life in an aviation exercise." That brought me bad luck and it didn't take long. On October 22, several days after having received your letter, I got up after having spent a very good night, quiet as usual. I jumped out of bed, and instead of being on my feet, I fell down on the floor without understanding why and how that happened. I knocked down an easy chair and I couldn't get up again. I called for help; they had heard my fall. When they came I couldn't talk anymore. I understood what had happened to me. The left side did not function anymore, the arm, the left leg, the tongue. The whole left side was inert. They put me to bed again and I called my doctor. We talked a long time. He made me confess everything, gave his prescription, and I kept it strictly and knew what to do. The attack had been violent, but had not been complete. The eye and the brain were not hurt. The interior organs also, heart, lungs, etc. and finally I could get over it without a relapse. The other attack has not happened. I do not predict it and don't feel it coming, and at last November 22 I have dinner at my table. I walk with the help of a person to whom I cling in this way. Last Sunday I had my first walk. There is a young person in whom I am very much interested, and who suffered from typhoid fever. I climbed down from the third floor. Oh Lord, how high it is! And I spent two hours with her father and mother. The little girl is doing well and will be cured. Then I climbed again to my third floor. I had never realized how high my roost is and how bad. Well, thanks to much help I reached my divan. And the next day it was all gone. The tiredness had left me and it doesn't show anymore. I expect "Little Mother" at noon who will make me take a good walk on the terrace and I hope that by the New Year I'll not need anybody anymore to move around; but how hard is it to need constantly the help of others, even to light a cigarette. My poor organs do not work anymore, especially on the left side. I have to be accompanied again. I have to start learning again, like a baby, learn again to walk, begin all over again. I have to have much patience. The right side isn't too bad. I can write as you see. In a month there will not be much left of the illness. Tonight I'll try to draw, to find out what I can do. I am very confident, for it is the brain that leads everything, and fortunately, it is not touched. I hope that it will be as before. But how sad not to be able to move, always need help. I just tried to draw and to make music. The drawing will soon be possible again. I am so awkward that it makes the others laugh, but in a month I'll be able to draw again. But music is a different matter. I am afraid that it will not be possible again. The left hand must be so often used and it is so awkward.

I don't doubt that my unhappy fate worries you, therefore I'll keep you informed of my resurrection which I hope will come about next year.

In this unhappy letter I wish you and all your beloved ones a happy new year, best remembrance and best wishes of good health and happiness.

A rather good symptom: Aviation has not died for me. I must have a tough life, don't you think. I believe it more and more. It is rather extraordinary, coming from a paralyzed person. But I have still these good eyes, and the models are many near me and tell me that it is possible. Three days ago, at noon, taking the air on my terrace, I showed my neighbors several flights of pelicans, one of which had a surface of 15 hectares. How many were there, thousands? None of us thought of counting them. They passed before us for a whole hour. They left the seaside and went south which indicates a severe winter. It was always the simple locomotion, every five minutes they described several orbits, in order to gain a little height, and took advantage of this elevation to make a long gliding toward the south. I have looked with great attention at the five photos that you were so kind to send me. I'll talk to you about them in my next letter.

Au revoir, dear Sir, for it is to be hoped that we will see each other some day. I shake hands with you as a friend with my right hand, for the left only makes a pressure of 4 kg.

I am very devotedly yours

Mouillard

January 12, 1897

Mr.. L. P. Mouillard

Dear Sir,

I was overcome by your letter telling me that you have been partly paralyzed, and I cannot tell you how much it affects me.

Fortunately the brain was not attacked, and you tell me that you are recovering the use of your limbs, but how you must have suffered by the fear of a permanent loss of power. I beg you to write to me as often as possible to reassure me on your behalf.

I am sending you a small sum that will pay for the mailing of some letters, and I would be glad to know your projects for the future and what dispositions you have made concerning our machine.

It was really by chance that your letter reached me at my home. My wife and two of my daughters have been very sick and the doctor told them to go to southern California. I should have gone with them, but my business kept me here, and I still don't know if I am going there to join them. I am doing nothing in aviation this winter, and I don't know if my funds will allow me to take up my experiments again next summer; still I will look forward to the observations that you announce about my experiments, and the advice that you will certainly give me to conclude them.

Au revoir, dear Sir, for like you, I have the hope that we will see each other some day.

I shake hands.

Sincerely yours,

O. Chanute

(Mouillard's letter of February 6, 1897 missing.)

May 20, 1897

My Dear Sir,

I received your letter of February 6 at the moment when I left for California to join my wife who had to spend the winter there for her health. Since I returned I was overloaded with work and I reproach myself that I didn't neglect some of it in order to write to you.

I do it today to announce to you that your American patent for airplane has been published at the date of May 18. I asked Mr. Whittlesley to send you some printed matter about it. I would have preferred to delay this publication still, in the hope that you would be able to demonstrate the value of your invention, but we were at the end of the legal delays. Now we have to take advantage of the patent. Let me know what your ideas are on this subject. I thought of two methods. One is to try out your machine again by a careful and skillful aviator, under your guidance. And the other is to have it sent over here to me to have it reconstructed and tested. If we can obtain a few good flights we could sell the patent; otherwise the money is lost.

You will receive at nearly the same time as this letter the "Aeronautical Annual" in which I give a detailed description of my experiments and which will answer your questions better than I could do it in a letter. You will see that number five was the least successful.

You will also find in this publication the end of my work on the gliding flight. I am dissatisfied with it. I believed that I could calculate all the acts of gliding flight and demonstrate how the bird takes his energy from the wind, but I hit a blank wall against breezes of 2 to 3 meters a second; and still the hawks make perfect use of them.

I hope that your health returns and that you have wholly recovered the use of your right side. I shake hands with you.

Cordially

O. Chanute

APPENDIX TO CHANUTE-MOUIILLARD CORRESPONDENCE

Apparently Mouillard was unable to reply to the letter from Octave Chanute dated May 20, 1897. On October 11, 1897 Chanute received word from G. Corelli that Mouillard had died on September 20, 1897. The Corelli-Chanute and related correspondence is added as an Appendix. They were translated from the originals in the Manuscript Division of the Library of Congress by Marvin McFarland on August 1, 1951.

One might guess that Corelli is the aide mentioned in Mouillard's letter of July 24, 1895:

"I am afraid of the practitioner, my clerk, who has to construct all the iron devices. He is an Italian. The smiths and mechanics here are all Italians. They speak an idiom among themselves... This Italian aide knows the machine as well as I do, but there is one thing that baffles him; he is conscious that I know flying by heart and he does not understand it at all. As I do not instruct him on the theory of flight, he searches I see but he does not understand anything about the equilibrium of the machine and about its control."

Also it is obvious why Chanute was so uncooperative about his suggestions.

Cairo
September 23, 1897

Mr. O. Chanute

Dear Monsieur:

It is with regret that I come to give you pain by announcing that our mutual friend and colleague, M. Mouillard, departed this life the 20th of this month at 3 o'clock in the morning and at the same day was taken to his last resting place.

It has taken me these several days to recover from this blow so unexpected at this time and which was the consequence of a third attack of apoplexy.

Brought back to relative calmness by this brief interval, I have reflected that I am the only person morally responsible to you to take care of his interests should there be any occasion to, since I was the sole collaborator in the construction of his last aeroplane, for which you furnished the funds and took out the Inventor's Patents.

None of his family being in Cairo to witness the irreparable loss of our dear friend, the French consulate as being its duty has affixed seals on all that belonged to him to be opened only by whoever has the right of inheritance.

As there will probably be no one to claim rights on the few things he has left, there being nothing of liquid capital, I am taking the liberty to inform you of the situation so that his studies on aviation, sketches, manuscripts, among others a book - the sequel of "L'Empire de l'Air" - and a disassembled machine itself, may be of very great utility for subsequent studies, may not be lost. On this subject besides giving you possession of these facts by the present letter, I shall submit this letter to M., your consul here so that he may take cognizance of it and may delay the decision to be taken by the French consul on the inheritance of our regretted Mouillard. Moreover, being in a position to furnish very valuable information on this question of aviation, I place myself at your disposal.

(Formal Closing)

G. Corelli

Memo. in Octave Chanute's handwriting:

Mouillard's assets:
Aeroplane (démonté)
1/2 American patent
Studies in Aviation
Sketches - manuscripts
1 Book - Le Vol sans Battement

Chicago
October 12, 1897

Mr. G. Corelli

Dear Sir:

I was very moved yesterday to receive your letter of the 23rd of September advising me that our friend Mouillard had departed this life. However, I had had a presentiment of it, not having received any reply to my last letter which concerned his interests; but it is very painful to think that he died without seeing the dream of his whole life - to obtain a first success in aviation - realized.

I thank you for your thought of safeguarding my interests. If I have some rights to the machine, which cost me 5000 francs, I beg you to claim them and accept them from me. If you should not wish to do so, it would however be well not to destroy this machine in view of the possibility that I may come to Cairo this winter or that a museum might want to have it.

It is otherwise with his studies on aviation, his sketches, manuscripts, etc. I should be happy to receive all that the family does not claim; notably my letters to Mouillard, which might be useful to me in preparing a notice later on. His book "Le Vol sans Battement" ought to be published, if a publisher can be found. I had pointed out some changes to be made but do not know if they were made.

The important thing to my mind would be to observe the desires of our regretted friend; you must know what they were, and I would be very obliged to you to inform me of them as well as of any valuable information on this question of aviation of which you speak.

I am holding at the disposal of his family one-half of the American patent for which I paid the expenses. It is scarcely possible to profit from it at this time, but should another person attain success with the same principle, the patent might be sold.

If some expenses have been necessary in complying with the last wishes of our friend, I beg you to inform me of them.

It is very sadly, sir, that I present you my civilities.

O. Chanute

Chicago
April 21, 1898

Mr. G. Corelli

Sir:

I duly received your letter of 23 September announcing the death of our regretted Mouillard. I replied on the 12th of October begging you to accept for yourself all my rights to the flying machine, the expenses of which I paid, and to send me such of his papers as his family did not claim.

I have received nothing from you since; please be good enough to let me know what has been done.

Accept my heartfelt civilities.

O. Chanute
413 E. Huron Street
Chicago, Ill.

Cairo
May 18, 1898

Mr. O. Chanute

Sir:

Finally your honored letter of 28 of April last has explained the mystery of your prolonged silence. Your letter of the 12th of October, 1897 I received on November 1 of the same year. And after having taken the necessary steps, I replied on the 8th of December 1897.

In that letter, which must unfortunately have been lost, I told you that I had an interview with the French Consul who claimed not to be able to honor your and my demands because the inheritance estate was not yet settled (as it is not even today), because the heirs attach no importance to it.

Several members of the French Colony, on the contrary, attach great importance to the works of the defunct, which is embarrassing to the consul and which causes him to add that it might happen that the five direct heirs today scattered around the world might unite to demand from him an account of his actions.

He advised me therefore to look up the heirs and make them understand why I desired to obtain these papers and to get from them a legal statement giving me the right to withdraw what these heirs might wish to give me. Faced with these difficulties and knowing what remains pertaining to aviation, I asked you if you thought it proper to pursue these courses and today I again repeat the same question, submitting my opinion to your judgment.

As for the machine. During the first experiment made in the mountains Abassieh the machine rose about 30 meters attached by a cord which I held in my hand. It glided down, yes, but veering transversely. It bumped against a hillock (boulder) and a spring of the undercarriage was broken. This experiment nevertheless showed that the course being followed was correct, but that the surface of the machine was too small to sustain a weight of 175 kg in the air (weight of the machine and a man).

In agreement with M. Mouillard we decided to take the whole thing back to the shop and increase the soaring surface to the dimensions which practice had dictated. This work required us to disassemble the machine to replace the spars of the wings, which were consequently too short.

It was at this period that our friend Mouillard was stricken of his second stroke of apoplexy and about a month later expired.

I mean, by its equilibrium when the machine is able to rise from the ground without a considerable effort with a load of at least 75 kilograms; or in other words, when the density of the air will offer the air a resistance such as to permit it to descend at a speed of 1 meter in 15 seconds.

Having obtained this result in absolutely calm weather, be it understood, it would then be possible to assist the horizontal flight of the machine with a propeller, which attached in front of the handlebars of the bicycle would be operated by the feet, which until now had no function to perform. Leaving aside, theoretically, the speed and force of the wind, which for this purpose would be unknown, I attack the principle of mechanics that it is necessary first to have equilibrium, and then power to obtain movement, applying therefore a little force I will have a very slow locomotion. It is in that set of circumstances that I intend to study the effects of the flights of the soaring birds, the principle cause of which is doubtless the speed and force of the wind.

Here I terminate, in summary, the first part of my studies in aviation and the little enclosed sketch will permit you to understand my ideas on the whole theory which I have just described to you.

The second part is concerned with the calculations for the resolution of the details of construction which if it takes place I will submit to you.

When you inform me what I am to do to be agreeable to you on the subject of the papers in question please add whether in your opinion I should pursue the studies which are the subject of my letter. From the ideas which I have just confided to you, you may decide whether I am to work alone or whether you would consider extending me your support.

Awaiting your reply, accept.....

G. Corelli

June 6, 1898
Chicago

Mr. G. Corelli

Dear Sir:

I have just received yours of the 18th of May. As you have guessed, I did not receive that of the 8th of December 1897 which you assumed I had received.

I already supposed that the estate of M. Mouillard had no pecuniary value but the important thing for his relatives and friends is to carry out his last wishes. What were they?

I suppose he desired that his last book "Le Vol sans Battement" should be published, so that aviation would not lose the fruit of his observations and labors. He wrote me that he intended to make some improvements and changes in the text. Did he make them? In any case, I recommend that there be an expert in aviation given the task of editing this book if it is to be published.

I have not seen a single notice of the death of our friend among the French publications which I receive. I am surprised and saddened. The inventions of M. Mouillard were, it is true, of little practicality, but his observations and his writings were, to my mind, of great value and his death leaves a void. I recommend that the French Consul and yourself get in communication with the heirs to obtain a document to permit you to examine the papers and carry out the desires of our friend. I would even be disposed in joining his other friends in bearing the expense, if there is any.

Since you do not want the machine, I will give it to a museum. Please let me know if there is a museum in Cairo which might want to take charge of it. I suppose that this machine belongs to me as I paid all the expenses but if it is necessary to pay a nominal sum at a public sale to obtain complete ownership, I will do so.

If I had a summary of the papers left by our friend, I might perhaps better be able to point out the use that might be made of them.

Tell the heirs that I still hold at their disposal one-half of the American patent, the expense of which I paid.

O. Chanute

Chicago
June 6, 1898

Mr. G. Corelli

Dear Sir:

I reply separately on the subject of your studies on aviation. Our friend Mouillard was on the wrong track in his latter days, proposing large surfaces to reduce speed. Still it was he who wrote, "no speed, no flight."

1) A surface of 120 sq m. is absolutely impracticable for a test aeroplane. I have established by experiments, of which I send you a copy, that a surface of 12 sq. meters to sustain a man without a motor and that for a machine with a 5 h.p. motor a surface of 16 sq. m. is enough; for that, one must resort to superposed planes. Folding surfaces have yet to be tried; I am afraid they could not be maneuvered in full flight.

2) The undercarriage as you propose it must be abandoned, but a simple runner is enough for the first experiments. I have obtained about 1000 glides by suspending a man by his shoulders.

3) It was in trying to regulate the movement of the tail by movements of the body that Lilienthal was killed. He attached it to his head; perhaps he would have succeeded better if he had attached it to his shoulders.

I do not think it practical to increase and diminish the surfaces in full flight in the first experiments. Later, one might come to that. The first thing to accomplish is to obtain automatic equilibrium in the wind; that is the most crucial point in which I was already directing my attention in testing two methods that are satisfactory and being engaged in trying a third method this summer.

You will see from my pamphlet which contains a lecture which I gave to the engineers the 20th of last October that I have built five machines of which two have succeeded in giving satisfactory equilibrium. I therefore do not wish to detour from this course to try the modifications of the Mouillard machine which you propose. But I am entirely in sympathy with researchers and it would give me pleasure to give you the information which my experience may suggest concerning your work.

O. Chanute

November 22, 1898

Mr. G. Corelli

Dear Sir,

I have duly received your letter of 18 May and I replied to you on the sixth of June.

I think that the estate of M. Mouillard must have been settled, and I should be grateful to you to let me know what has happened.

What were his last desires? Is his book to be published? What has become of his papers? Is there a museum which would accept his aeroplane?

O. Chanute

Chicago
February 3, 1910

M. de Consul de France
Cairo, Egypt

Dear Mr. Consul,

In 1894-95 I furnished M. L. P. Mouillard of Cairo certain sums to build an aeroplane with which he made some interesting experiments in 1896 and I took out an undivided patent in the USA.

M. Mouillard died the 20th of September, 1897 and when I passed through Cairo in 1902 [Chanute was in Cairo June 20 to February 1, 1903] the French Consul told me his natural heirs had refused to accept his estate, that his effects were on deposit at the consulate, and would be sold subject to legal postponement.

Be so good as to let me know what the terms of this sale are to be. The effects contained the manuscript of a book "Le Vol sans Battement", which I had read and corrected in part and which would be worth publishing at present; and the undivided half of his patent which might be exploited in the USA.

I would be disposed to occupy myself with these two affairs.

Yours truly,

O. Chanute

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November 16, 1891

Mr. L. P. Mouillard

Dear Sir.

Professor Langley asks me if it would give pleasure if a naturalist of the Smithsonian Institution would write an article on the flight of the birds, giving quotations from the "Empire de l'Air" and the "Vol sans Battement." This publication would only be scientific and you wouldn't get anything out of it but renown.

Considering your book like a "fidei commis" I cannot show it without your permission, but I don't see any disadvantage in showing the purely descriptive parts. Even for the other parts, I have such faith in Mr. Langley that I should be happy to be able to communicate to him all your ideas so that together we could try to find out what profit can come of it.

There are some among them that could be offered to the Government, for instance, the large boat, and Mr. Langley has such a high place in Washington that his help would be invaluable.

I am afraid you think that I don't act quickly enough in your interest, and I wish to hasten the realization of your hopes.

Yours truly,
O. Chanute

November 27, 1891

Letter from L. P. Mouillard to O. Chanute
MISSING

Cairo
December 10, 1891

Mr. O. Chanute

Dear Sir,

This is my answer to your other letter. Dear Sir, I am telling you again what I already wrote you several times before: you are entirely at liberty to do whatever you think is for the best. However, in the present case I must confess that I am flattered and glad to hear that you got in touch with Mr. Langley. I have not the honor of knowing the President of the American Institute; I am not in any position to judge him but in spite of myself and without the shadow of an effort, thanks to you, I put myself under his kind protection. Please do share with him everything, absolutely everything I confided in you pertaining to aviation and maritime ideas. Whenever you have a chance to see him or write him I beg of you to be kind enough to convey my deep gratitude for the interest he has shown so generously. Perhaps I should thank him directly myself but I do not wish to bother him with any letter of mine. I was bold enough to write him when I thought he was concerned, but since it is my turn now to be so it is quite different.

Your devoted
Mouillard

December 15, 1891

Letter from L.P. Mouillard to O. Chanute
MISSING

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